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LANTANA INSECTS IN INDIA

BEING THE REPORT ON AN INQUIRY INTO THE EFFICIENCY OF INDIGENOUS INSECT PESTS AS A CHECK ON THE SPREAD OF *LANTANA* IN INDIA

BY

RAO SAHIB Y. RAMACHANDRA RAO, M.A., F.E.S

Entomological Assistant, Madras (on Special Deputation on Lantana *work under the Imperial Entomologist)*

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PREFACE

THE following Report, by Rao Sahib Y. Ramachandra Rao, deals with an investigation regarding the insects found on *Lantana* in India, made with the idea of discovering whether there exists in the Indian Empire any insect which is capable of proving an effective check upon this plant. The author has given an excellent account of his work and his Report will perhaps assist to bring home the facts not only that *Lantana* has been distributed until it has become a noxious weed in most parts of India and Burma, but also that various other plants which have been introduced for ornamental purposes have also got, or are getting, out of hand and are likely to prove sources of considerable trouble and expense to the country in the near future. What seems to be required is a regular Weed Survey and the adoption of necessary restrictions on the spread of noxious species *before* they have got out of hand.

Lantana is itself an excellent example of the danger of the indiscriminate introduction of a plant which, originally introduced as an ornamental shrub on account of the beauty of its flowers, has escaped from cultivation and become a nuisance in many districts and a regular pest in localities which have suited it. India is not the only country which has suffered, for *Lantana*, originally a native of South and Central America, has been introduced by man into most parts of the Tropics, and in all suitable localities it has run wild and proved itself a noxious weed. I myself have seen a good deal of *Lantana* and have paid some attention to its spread, not only in India, but also during four years' experience in Ceylon and also in Hongkong, Singapore, Mauritius and the Seychelles, in all of which localities it has run wild and displaced the native vegetation.

The Hawaiian Islands form one of the best known cases of the invasion of *Lantana* on account of the measures taken there to combat it by means of its natural insect enemies, which appear to have checked its spread efficiently. These insects were brought from Mexico where Mr. Koebele spent some time in investigating the insects attacking *Lantana* and those which he considered of importance as a check and safe as regards other vegetation were sent in numerous consignments to Hawaii, where they were

handled by Dr. Perkins, who again carefully selected and liberated only the best and safest species. It should, however, be remembered that the conditions in Hawaii are peculiar and markedly different from those in India, owing primarily, as Dr. Perkins has said, to the remote position of this group of islands whereby the limited indigenous fauna gave free scope for increase to the new arrivals, the general absence of creatures injurious to the introduced beneficial species, and the equability of the climate, allowing of almost continual breeding, affording results which could hardly be attained elsewhere on the globe. The keen struggle for existence of continental lands is in Hawaii comparatively non-existent and, so far as it exists, is rather brought about by the introduced fauna than the native one. It is by no means certain therefore that the Agromyzid which has been claimed as successful in attacking *Lantana* seeds in Hawaii and which has been introduced from Hawaii into Noumea, Fiji and Australia, would be equally successful if introduced into India. It must not be overlooked also that in Hawaii this Agromyzid has attacked *Lantana* in the almost complete absence of any other closely-allied plants. In a letter to me, in reply to a request for information on certain points regarding the control of *Lantana* by insect pests, Mr. D. T. Fullaway, Entomologist to the Board of Commissioners of Agriculture and Forestry, Hawaii, states that he knows of only one tree (*Vitex trifolia*) which has drupaceous fruits like *Lantana* and suitable for the work of the Agromyzid but he is unaware of any attention having been paid to the question of whether the *Lantana* Agromyzid has also attacked these fruits. In India, on the other hand, the Natural Order Verbenaceæ (to which *Lantana* belongs) is represented by numerous common species belonging to the genera *Verbena, Duranta, Tectona, Gmelina, Vitex, Clerodendron, Avicennia*, etc., some of which might prove suitable alternative foodplants, should this Agromyzid be introduced with the object of checking the spread of *Lantana* in India. Experience alone can tell whether it would or would not attack such other allied foodplants and such experience would probably only be attained after such thorough establishment of the Agromyzid that its extermination, if considered desirable, would be impossible. As Dr. L. O. Howard has well remarked (*Journ. Econ. Entom.*, VIII, 456), "the introduction of insects to feed upon weeds or other plants is a dangerous experiment and it is very fortunate that it turned out so well in this case." Mr. Fullaway, who is probably more familiar with the subject than anyone else on account of his practical experience in Hawaii, writes :—"I consider that you are quite right in approaching the matter with caution. I myself am not prepared to go further than to say that the insects have been a distinct benefit here." I cannot therefore recommend

the introduction into India of this Agromyzid without previously making sure, as far as is possible, that it will confine its attention strictly to *Lantana*.

Rao Sahib Ramachandra Rao's investigations have brought to light a long list of insects also present and attacking *Lantana* in India and Burma. The most efficient of these is *Platyptilia pusillidactyla*, a small Plume-moth whose larva feeds in the flower-heads and reduces the output of seeds to a considerable extent, attacked flower-heads producing only a few sickly berries instead of a number of healthy ones. It is already widely distributed throughout India, Burma and Ceylon, and would be even more efficient than it is were not its numbers considerably reduced by the attack of Hymenopterous parasites.

In any case, it should be noted that no insect is likely to do more than act as a check, *i.e.*, many seeds will be unattacked and will be spread. I doubt whether any form of insect control will obviate altogether mechanical methods such as cutting and burning, and I have seen a good deal of *Lantana* under very varied conditions in and outside of India. Even under the extraordinarily successful conditions in Hawaii, *Lantana* has not been exterminated and its spread has only been checked to some extent.

In the meantime vigorous efforts should be made to check the spread of *Lantana* in those districts in India and Burma which are at present only lightly infested and to prevent its entry into areas hitherto unaffected. It is folly to wait until a pest of this kind has got out of hand before attempting to tackle it.

T. BAINBRIGGE FLETCHER,
Imperial Entomologist.

PUSA:
The 22nd June, 1919.

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CONTENTS

		Page
1.	Introduction	239
2.	Itinerary	241
	Acknowledgments	243
3.	The Lantana plant	244
	Allied plants	245
	Vernacular names	246
	General characters	*ib.*
	Life-cycle	248
	Economic uses	249
	Varieties	250
	Lantana indica	252
4.	Fertilization of Lantana flowers	253
5.	The Lantana problem	259
	Methods of eradication	261
6.	Distribution of Lantana	263
	(*a*) Factors controlling the Distribution of *Lantana* ..	*ib.*
	(*b*) Distribution of *Lantana* in India and Burma	266
7.	Insects found attacking Lantana in India ..	277
	(*a*) Conditions under which the Inquiry was conducted ..	*ib.*
	(*b*) The *Lantana* insects	279
8.	Conclusions	306
9.	Other pestilential weeds	310

PLATYPTILIA PUSILLIDACTYLA.

Explanation of Plate XXIV.

Platyptilia pusillidactyla.—

1. Twig of *Lantana camara*, showing leaves, flowers (orange-yellow variety) and fruits (natural size).
2. Egg, as laid on flower, magnified (×7)
3. Egg, more highly magnified (×43).
4. Flower attacked by larva. Note sickly appearance in comparison with healthy flower on left.
5. Flower attacked by larva, opened up, showing larva at base of flowers, magnified.
6. Larva, magnified (×7).
7. Fruit-cluster formed from flower-head in which a larva has fed and pupated. Note scanty formation of fruits in comparison with healthy cluster on left.
8. Enlarged view of attacked flower-head in which a larva has pupated. The head of the pupa is seen projecting from the interior of cocoon which has been partially opened.
9. Pupa, magnified (×7).
10. Moth, in resting position, natural size.
11. Moth, with wings expanded, magnified.

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[Received for publication on 27th June, 1919.]

1. INTRODUCTION.

Lantana aculeata (= *camara*) is one of several species of the genus which are indigenous to America. Being the happy possessor of indisputably beautiful flowers, it has come within the purview of the Horticulturist always in search of fresh acquisitions to beauty in the floral world. Originally introduced into Botanical gardens and thence distributed for purposes of a live fence, it has travelled from land to land until it has become a denizen of almost all the tropical regions of the world. Nowhere did the people realize how much harm the plant was capable of, until it was beyond their power to check it. The fruits being edible, birds were soon noted feeding on them and functioning as active agents in the dispersal of its seeds, so that within two or three decades the plant turned into a troublesome weed of the first magnitude. In Hawaii *Lantana* appears to have been introduced about 1858; by the eighties it had increased enormously and become a serious problem for the ranchmen (*Tropical Agriculturist*, Apr. 1904, p. 657). About 1900, Mr. A. Koebele, an Entomologist in Hawaii, with previous experience in the introduction of parasites, hit upon the idea of examining the plant in its reputed original home in Mexico. He actually visited Mexico in 1902 and his

examination of *Lantana* in that country led to the discovery of innumerable insects feeding on it and keeping it in complete check in its home. Out of nearly 400 different insects noticed as pests on the plant, he selected those that might be introduced into Hawaii with safety, carefully eliminating those that were pests on economic plants, as well as those that might be suspected to have leanings in that direction. Out of the numerous insects noted by him, he sent by parcel live material of only 19 different species to Dr. Perkins at Hawaii, who in turn, after selection, set free practically only eight of them. (*Hawaiian Forester*, Vol. VI, No. 8, p. 328; O. Swezey, *Journ. Econ. Entom.*, Vol. VIII, Oct. 1915, p. 453). Among these, the success of the seed-Agromyzid, the maggot of which feeds inside the immature *Lantana* berry and destroys its germinating power, was reported to be instant and phenomenal. The rest consisted of

2. 2 *Moths*: *Platyptilia pusillidactyla*
3. *Crocidosema lantana** } The larvæ of which feed on flower clusters.
4. 2 *Butterflies*: *Thecla echion*
5. *Thecla agra* } Larvæ feeding on flowers.
6. A Microlepidopterous moth: *Cremastobombycia lantanella*, a miner in leaves.
7. A Tingid bug: *Teleonemia lantanæ*, feeding on the underside of leaves and causing them to fall off.
8. A Gall-fly: *Eutreta sparsa*, causing swellings in freshly growing shoots.

While all of them have proved effective checks on *Lantana* none of them, it is reported, has become injurious to any cultivated plant in Hawaii. "The insects, of course, did not exterminate *Lantana* but were highly effective in checking any further spread of the plant and rendered it possible for any one to clean *Lantana*-covered land once and for all, without fear of having to perform this work at intervals of every few years." The usefulness of the introduction of Mexican insects into Hawaii was, however, somewhat marred by the importation, privately, by ranchmen from a neighbouring island, of the *Lantana* Bug, *Orthezia insignis*, which is polyphagous in habits.

The successful results achieved by this method in Hawaii induced various other Governments to try it in their country. In 1908-09 a shipment of the seed-fly was reported to have been made for New Caledonia from Hawaii (Tryon, *Queensland Agr. Journal*, Dec. 1912), and in 1912 the fly appears to

* This species is not included in the *Fauna Hawaiiensis*, but was described by Busck (*Proc. Ent. Soc. Wash.*, XII., 132 [1910]) from Central America and Hawaii. The only Indian species of this genus (*C. plebeiana*, Z.) is attached to Malvaceæ. [T. B. F.]

have been successfully established there. According to Pamphlet No. 21 of the Fiji Department of Agriculture of 1916, Mr. F. P. Jepson, Government Entomologist, Fiji, visited Hawaii in 1910 and introduced the seed-fly in 1911. The pamphlet reports successful results.

Mr. W. W. Froggatt, Government Entomologist, New South Wales, up to as late as 1916 appears to have treated the subject with very great caution. He appears to have considered that the conditions in Australia were so different from those of an Island where the main crop may be sugarcane or coconuts, that no berry- or seed-eating fly should be brought in.

In Queensland, on the other hand, Mr. Tryon, with his world-wide experience in connection with the study of Cactus insects, sent Mr. Jarvis, Assistant Entomologist, to Hawaii in January 1917 and then to Fiji for bringing the seed-fly for introduction into Queensland. A large number of flies was successfully imported and liberated in March 1917 into Queensland.

The successful results reported in Hawaii, New Caledonia and Fiji, naturally raised the question as to why the introduction of the seed-fly should not be tried in India, to combat the heavy infestation of *Lantana* in the Forest areas of the Western Ghats. The Government of India referred the problem to the Imperial Entomologist and to various other responsible Entomologists in India for their individual opinion, whereupon all the Entomologists were, on the whole, unanimous in their note of warning as to the danger involved in importing foreign insects generally, owing to the possibilities of insects imported developing new and injurious characters and habits in their new environments. They were further of opinion that, before seeking to introduce Mexican insects from Hawaii, it was advisable to find out first whether in a vast country like India, there was not existent in some corner or other an indigenous insect, which was capable of checking the growth of *Lantana*. If such an insect was discovered, it would be far easier and safer to introduce that insect from one part of India to another, than to ship in a possible danger from distant lands.

Such was the genesis of my deputation for the purpose of making an inquiry as to the efficiency of existing indigenous insect pests on the check of *Lantana* in India.

2. ITINERARY.

On the 15th November, 1916, on receipt of orders from the Government, I was relieved by the Government Entomologist, Coimbatore, of my duties as Acting First Assistant, and since that date I worked under the immediate control of the Imperial Entomologist till the termination of the deputation on the 31st March, 1919. Under his instructions, I began work at Coimbatore.

Though *Lantana* is not abundant in that place, the time at which the work was started, being the end of the North-East Monsoon, was exceedingly opportune and numerous insects were noted on *Lantana* and a good beginning was made. Except for short visits to Mettupalaiyam, Kallar, Coonoor and Bangalore, I remained at Coimbatore till the end of January 1917. In February 1917, I visited Pusa in connection with the Second Entomological Meeting and also attended to the identification of insects collected so far on *Lantana*. In March 1917, I proceeded to Sidapur, Coorg, in accordance with the directions of the Imperial Entomologist, and remained there till the 15th July, excepting a period of about a month in June 1917 when I was away on privilege leave. Various places in Coorg were examined in May 1917. Bangalore, the Shevaroys and Coimbatore were visited in August, and the Nilgiris in September 1917. I awaited the arrival of the Imperial Entomologist early in October in Bangalore, but on receipt of a telegram to the effect that he had altered his programme, I visited some of the localities around Bangalore, such as Tumkur, in the Mysore State. Leaving Bangalore on the 25th October, 1917, I visited Coorg, Wynaad, parts of Malabar and the Anamalai Hills during the months of November and December. I was at Bangalore during Christmas and left the place for Pusa with the collection and records on the 16th January, 1918. Reaching Pusa on the 20th January, 1918, I remained there attending to the arrangement of the collections, the identification of insects reared on *Lantana* and the preparation of a preliminary report on the results of the *Lantana* investigation. On the 3rd February, 1918, I left Pusa for Burma under the instructions of the Imperial Entomologist. Leaving Calcutta by steamer on the 6th, I reached Rangoon on the 9th February and toured in Burma till the 12th May, 1918, visiting during this period the following places : Rangoon, Insein, Hmawbi, Prome, Moulmein, Thaton, Pegu, Pyinmana, Thazi, Meiktila, Mandalay, Maymyo, Anisakan, Hsipaw, Lashio, Kanbalu, Naba, Myitkyina, Bhamo and Kalaw. Leaving Rangoon by steamer on the 13th May, I reached Calcutta on the afternoon of the 16th and Pusa on the morning of the 19th May, 1918. Having been instructed by the Imperial Entomologist to join him at Shillong, I left Pusa on the 27th May and reached Shillong on the 29th. I worked in Assam till the 30th July, visiting during this period Shillong, Cherrapunji, Barapani and Gauhati. I returned to Pusa on the 1st of August, 1918. The Ramandrug Hills in the Bellary District were next examined and thence, after visiting Dharwar, Londa and Castlerock in South Bombay, and Shimoga, Sagar and Bangalore in Mysore, I returned to Pusa on the 26th September, 1918. The Punjab was next visited ; reaching Gurdaspur on the 12th October, I paid visits to Pathankote, Madhopur, Dhariwal and Lahore.

Owing to certain domestic calamities that befell me during the influenza epidemic, I had to proceed home on privilege leave and during my absence Mr. G. R. Dutt of Pusa worked in my place, visiting Gurdaspur, Lahore, Sialkote and Jhelum. After an absence of 25 days, I returned to duty at Gurdaspur on the 19th November, 1918. On the 20th I visited Hoshiarpur and returned to Gurdaspur on the 22nd. Having received instructions by wire from the Imperial Entomologist, I moved down, on the 24th November, to Dehra Dun in the United Provinces. At Dehra Dun, I attended to the examination of *Lantana* and with the kind assistance of the Forest Zoologist and the other officers of the Forest Research Institute obtained information regarding the distribution of *Lantana* in India and especially with reference to the United Provinces, Bombay and the Central Provinces. I also visited Rajpur and Masuri. Kathgodam and Haldwani were examined between the 5th and the 14th December. A short visit was also paid to Nainital. Lucknow was examined on the 15th December *en route* to Gorakhpur where a stay of 12 days was made. Cawnpur was reached on the 28th December. Dariaogunj on the Cawnpur-Agra Branch of the B. B. & C. I. Ry. was examined on the 15th January, 1919. From Cawnpur I proceeded to Jabbalpur on the 7th January, whence after a stay of 4 days I moved down to Nagpur on the 12th January. From Nagpur I reached Ellichpur on the 20th and Chikalda in Melghat on the 23rd January. Leaving Chikalda on the 26th I reached Pusa on the 31st January, 1919. In February I attended the Third Entomological Conference and prepared a paper for the same. I stayed at Pusa till the 31st March, 1919, attending to the naming of *Lantana* insects and the preparation of this report on the results of the investigation.

ACKNOWLEDGMENTS.

I beg to acknowledge with thanks the willing help received from the following gentlemen during the progress of this inquiry :—

Coorg. F. Hannyngton, Esq., I.C.S., then Commissioner of Coorg.

Father Cochet, of the Roman Catholic Mission at Virajpet, for identification of botanical specimens.

Coimbatore. Mr. T. V. Ramakrishna Ayyar, B.A., F.E.S., F.Z.S., Ag. Government Entomologist, for kind loan of entomological apparatus and for kindly allowing me to work at his Laboratory during my stay at Coimbatore.

Mr. C. Tadulingam for kindly identifying botanical specimens.

Bangalore. Dr. L. C. Coleman, Director of Agriculture; Mr. K. Kunhi Kannan, M.A., F.E.S., Senior Assistant Entomologist; and Mr. Charles

Noronha, B.A., Mycological Assistant, for working at *Lantana* stems attacked by fungus.

Coimbatore. Mr. C. D. McCarthy, Conservator of Forests, Coimbatore.

Yercaud. Mr. R. W. B. Gompertz and Mr. Charles Dickins, Planters.

Nilgiris. Mr. J. F. Nicholls, Manager, Devarashola Estate.

Anamalais. Mr. J. H. Robinson, Valparai.

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The Punjab. Maulvi Fateh-ud-din Sahib, Deputy Director of Agriculture, Gurdaspur; E. A. A. Joseph, Esq., I.C.S., Director of Agriculture, Lahore; and Mr. W. R. Mustoe, Superintendent, Lawrence Gardens.

United Provinces, Dehra Dun. B. B. Osmaston, Esq., President, Forest Research Institute; C. F. C. Beeson, Esq., I.F.S., Forest Zoologist; R. S. Pearson, Esq., I.F.S., Forest Economist; and R. S. Hole, Esq., I.F.S., Forest Botanist.

Gorakhpur. Mr. Marriot, District Forest Officer.

Cawnpur. H. M. Leake, Esq., Principal, Cawnpur Agricultural College.

Central Provinces. D. Clouston, Esq., M.A., Director of Agriculture; R. G. Allan, Esq., M.A., Principal, Agricultural College, Nagpur; and Mr. J. L. Khare, Lecturer in Entomology, Nagpur.

3. THE *LANTANA* PLANT.

Lantana is a genus of world-wide distribution, belonging to the natural order Verbenaceæ and contains about 50 species, of which the greater number are natives of America.

Lantana aculeata, Linn. (=*camara*, Linn.) is, according to the *Index Kewensis*, a denizen of the Tropical American Region, comprising Mexico, Central America, Bolivia, Guiana, Brazil, etc. It is an introduced species in India.

"A large, much branched, gregarious, prickly shrub ; branches quadrangular, grooved, clothed with recurved prickles. Leaves with the odour of black currants when crushed, ovate, acute at the apex, acute or rounded at the base, crenate-serrate, thick, scabrous above, softly pubescent beneath ; lateral nerves 6 pairs, strong beneath ; petioles 0·5″—1″ long. Flowers in peduncled, bracteate heads 0·5″—1·5″ in diameter ; peduncles angled, 0·5″—3″ long, dilated at the top, pubescent ; bracts ovate or linear, 0·2″ long ; shorter upwards. Calyx small, membranous, pubescent. Corolla 0·25″ long, tube pink ; limb pink or orange. Drupe 0·15″ in diameter, dull-purple, enclosed in the membranous calyx." Description from Talbot's *Forest Flora of Bombay*.

It is reported to have been introduced into Ceylon, first about 1824, and it is probable that it reached India about the same time.

Lantana indica is the indigenous representative of *Lantana aculeata* in India. It may be easily distinguished by the soft velvety leaves, the branches devoid of prickles, the long bracts, and the elongate flower-spikes. According to the *Index Kewensis*, the distribution of *Lantana indica* covers the whole of Tropical Asia and Africa.

Allied plants.

The following are some of the more common or important plants in India which belong to the same Natural Order Verbenaceæ and are thus related or allied plants of *Lantana*. A knowledge of these is important, as they are more likely to be affected than other Indian plants, in case foreign insects are imported to check the growth of *Lantana* in India.

1. *Lantana indica*. Shrub, found throughout India.
2. *Lippia geminata*. An introduced plant, naturalized in Eastern India.
3. *Lippia nodiflora*. A herb, found throughout India.
4. *Verbena bonariensis*. A Brazilian herb found naturalized on the Nilgiris and the Himalayas.
5. *Vitex negundo*. A shrub, common throughout India.
6. *Vitex altissima*. A large tree ; Coorg, etc.
7. *Symphorema involucratum*. A climbing plant.
8. *Premna tomentosa*. A common shrub of South India and the Central Provinces.
9. *Premna integrifolia*. A small tree or shrub of South India.

10. *Tectona grandis* (Teak). A very valuable timber tree, throughout India and Burma.

11. *Tectona hamiltoniana.* A large tree, Burma, etc.

12. *Clerodendron inerme.* A common hedge-plant.

13. *Do. phlomoides.* A common South Indian shrub.

14. *Do. infortunatum.* Common herb.

15. *Callicarpa lanata.* Moderate-sized tree, common throughout India and Burma (The Coorg Lilac).

16. *Callicarpa arborea.* Tree of North India.

17. *Gmelina arborea.* Common tree.

18. *Gmelina asiatica.* Common shrub ; South India.

19. *Sphenodesma* sp. Lower Burma.

The Vernacular names of *Lantana aculeata* in India.

Coorg. Gulabi, Unni-gulabi (lit. Tick rose), *Lanthana.*

Mysore Malnad. Chadurangi, Chadurangada matte.

Tamil country. Unni chedi (lit. Tick plant), *Unni mullu* (lit. Tick thorn).

Malabar. Arippū.

Ramandrug. (Bellary District). *Kâki-gida.*

Dharwar. Lavangada-kanti, Hesigé-kanti.

Mahratta country. Ghanéri (evil-smelling), *Tântâni* (around Poona according to Cooke's Bombay Flora).

Chikalda, Melghat Taluq (Berar). *Rai-munia.*

Kathgodam (*Nainital Dist.*). *Kurai* (?), *Ban-Tulsi, Lal-thana.*

Cawnpur. Known sometimes as "*Khajur*" owing to its fancied resemblance to the *date-fruit.*

Madhopur (*Gurdaspur Dist.*), Punjab. *Panj-phuli.*

Assam. Bon-mosla (lit. wild spice) (according to Rai Bah. U. Kanjilal).

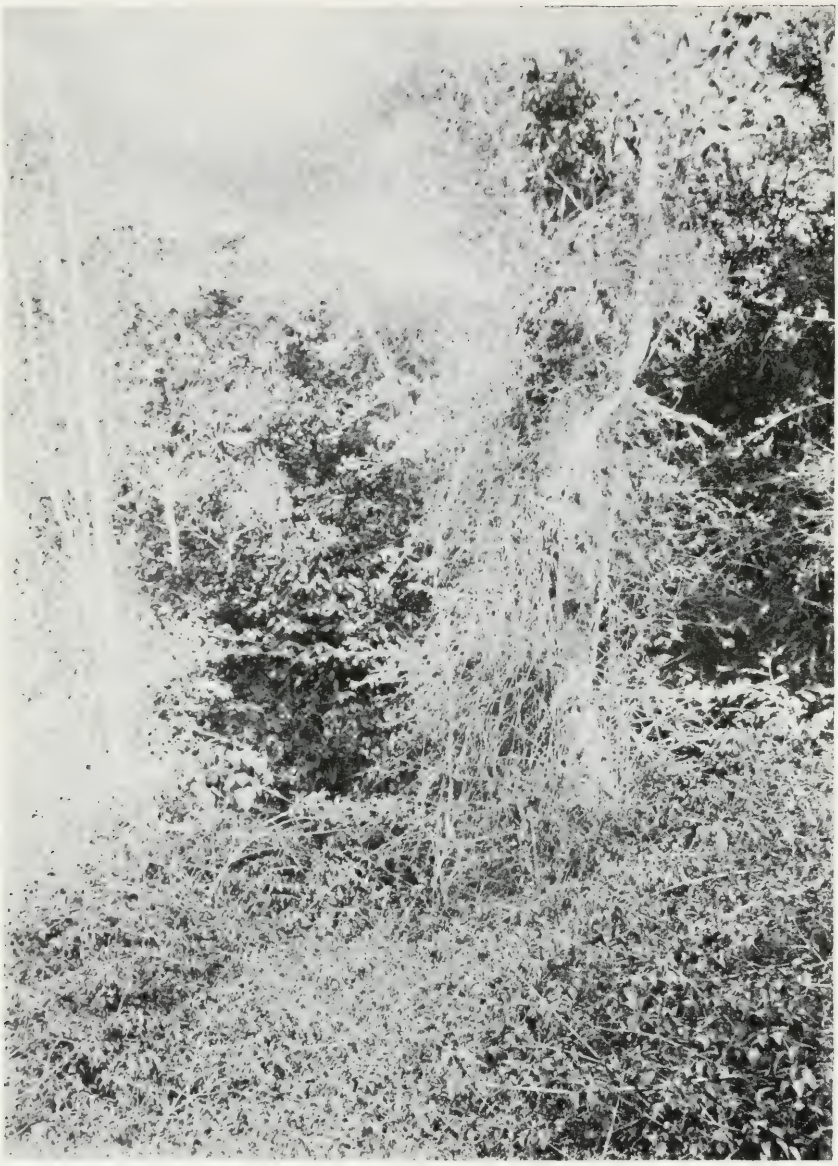
Khasi Hills. Dieng-syntem-lahari (Kanjilal)

Lushai Hills. Hlow-rim-si (Kanjilal).

Burma. Sein-nagat-pan (lit. diamond earring-flower), *Sein-naban-lit.* (diamond ear-ornament).

General characters.

Lantana aculeata is a large-sized shrub growing to the height of 3 to 10 ft., rarely attaining the size even of a small tree. In dry areas the bushes are stunted and the branches stiff and short, but in moist tracts the plant shows tendencies of spreading, the branches developing into thin and extremely long runners, not unusually measuring 30 or 40 feet. The branches of neighbouring bushes generally run into one another and become interwoven



Lantana climbing up a tree-stem at Sidapur, Coorg, April 1917.

into an extremely tangled mass, leading to the formation of very dense thickets, covering large areas of ground which neither man nor beast can penetrate. Where the requisite support is available, as around the stems of tall trees or around bamboo clumps, *Lantana* exhibits decided scandent habits, the branches climbing up along their sides, mainly helped by the grip afforded by their prickles. In some places *Lantana* is known to reach a height of nearly 30 feet. (Plate XXV.)

In almost all varieties that have run wild in India, prickles are prominently present, but in certain of the cultivated varieties they may be absent. The prickles generally drop off as the branches increase in girth and age. The leaves are generally rough above and hairy below ; and there are some varieties in which the hairs are specially numerous.

The flowers are produced in close clusters of 25 to 50 and form corymbose heads borne at the top of long axillary peduncles. The flower is small and tubular, the limb being divided into 5 unequal lobes. The colour of the flowers is very variable and differs much in the different varieties. Moreover, the colouration of recently open flowers is different from that of flowers a day or more old, while in certain kinds a further change occurs as they grow older yet.

When fertilized, the flower-heads set into globular masses of rounded fruits. The immature berry varies in colour from a light to a dark green ; as it ripens, it assumes a colour varying from a greyish blue to a bluish black. The fruit may, when fully ripe, drop to the ground or may sometimes dry up and remain attached to the peduncle. The fruit is a drupe.

It possesses a soft sweetish pulp enclosing a single "kernel" which is a top-shaped, more or less hollow, hard, bony structure. It is formed by the fusion of two pyrenes and contains two seeds lodged in distinct cells.

FIG. 1. Side-view of *Lantana* seed (×10).

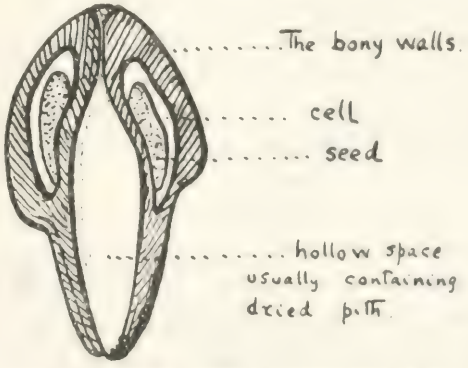


FIG. 2. Section through a *Lantana* seed (×10).

The "kernel," when cleaned, presents in certain aspects a curious resemblance to a head with a helmet on.

On the 14th March, 1917, a few seeds were placed in a shallow dish containing fine earth which was regularly moistened at intervals. The first seed germinated on the 26th March, 1917, and more were noted sprouting at intervals of 3 or 4 days. The last one actually observed to germinate was on the 28th May, after which observations were discontinued. Whereas in one case both the seeds in a stone sprouted at the same time, generally one germinated earlier than the other. One of the two was often a weakling. When sprouting the swelling embryo pushes open one of the projecting sides of the "helmet" and escapes to the outside and is thereafter quite unconnected with the "kernel". In view of the fact that in *Lantana*-infested areas the ground below the bushes is often covered with masses of fruits, which remain quiescent so long as they are denied sunshine, experiments for determining the length of time during which the seeds can retain their germinating power will be of much interest and great value.

Lantana is decidedly a surface-feeder and is shallow-rooted. The tap root may reach at the utmost a depth of about a foot, but usually radiates not much below surface-level into branches which divide and subdivide until the rootlets ramify the whole of the surface-soil. An examination of the soil under a *Lantana* thicket will easily show how thoroughly honey-combed it is with the ramifications of its root system.

Life-cycle.

The plant is a perennial and I have reason to believe is long lived ; I have not come across any bushes, in long established areas, that looked as if they were dying of old age. It is possessed of an extremely high vitality. It is capable of propagation by cuttings, and parts of stems or main roots, that may be left in the ground when the plant is carelessly cut, readily put forth shoots and regenerate the plant. In the moister tracts it flowers throughout the year, but in places affected by drought it may dry up partially or completely. Shoots and buds are always produced in abundance soon after the first heavy showers.

The sweetish pulp of the fruit renders it attractive to many animals, chiefly birds, and even to boys in the countryside. The fruits are generally swallowed entire and the hard seeds pass through the alimentary canal absolutely unharmed, and germinate wherever they are conveyed with the droppings of birds. The wide dissemination of this plant is thus, as in the case of *Ficus*, brought about mainly by the agency of birds. The ripe fruits when

Fig. 1. Birds' droppings, consisting mostly of *Lantana* fruits, along edge of canal at Kathgodam, U. P., December 1918.

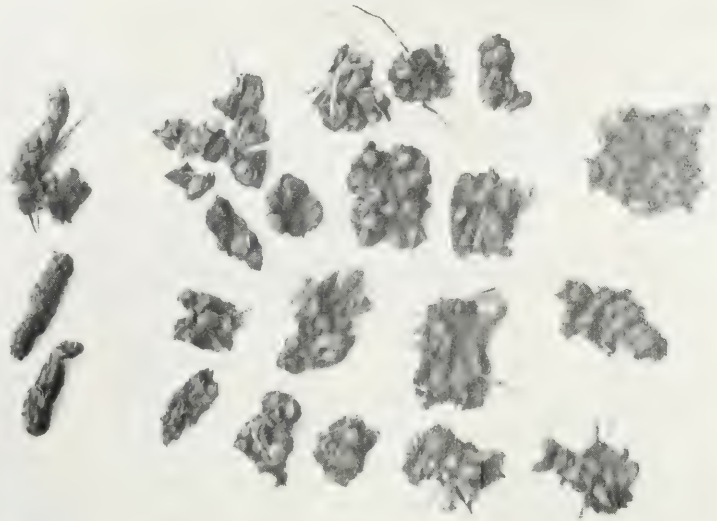


Fig. 2. Excreta of birds, containing *Lantana* seeds and found under trees at Dariaoganj, U. P., in January 1919.

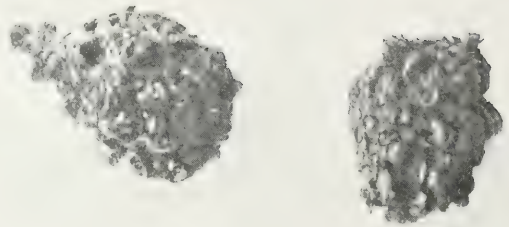


Fig. 3. Excreta of a mammal, containing numerous *Lantana* seeds; Ramandrug. July 1918.

dry are light and float on water. As *Lantana* bushes are generally fairly common on the banks of natural watercourses and along the margins of irrigation canals, it is quite conceivable to suppose that the dry *Lantana* fruits would be carried down the stream, especially when swept down by rain, and deposited in fresh localities lower down. This would appear to be another way by which the dispersal of the seed is brought about. The bird that goes to *Lantana* more than any other is the Bulbul, *Molpastes hæmorrhous*, which may be seen, especially of evenings, flitting about noisily from branch to branch on the bushes, and feeding on the ripe fruits. The sparrow, the mynah, the parrot, the crow and the ring-dove are some of the other birds that are known to feed on the ripe berries.

The excreta of the Bulbul are elongate, torpedo-shaped objects about an inch long, usually consisting of 3 or 4 *Lantana* seeds cemented together by a blackish mucoid matrix. They are generally noticeable under *Lantana* thickets, but, at Kathgodam, their droppings were found scattered in numbers on the brinks of the canals which they had the habit of frequenting when not on the bush (Plate XXVI, fig. 1). Another type of excreta, which were flattened and disc-shaped in the dry condition and contained several *Lantana* seeds, were noted on the sandy soil under trees at Dariaeganj in the United Provinces, and might presumably have been ejected in a semi-liquid condition by a larger bird, possibly the mynah or the ring-dove. (Plate XXVI, fig. 2).

In Coorg, at Ramandrug and at Chikalda on several occasions I came across mammalian excreta of fairly large size, dropped on the ground near *Lantana* bushes. They consisted almost entirely of uncrushed *Lantana* fruits and seeds, sometimes mixed up with bits of crushed elytra of beetles of sorts. From the size of the droppings and the evident inclusion of insects in the diet of the animal, it is very likely that the excreta belonged to an omnivorous mammal, possibly the jackal. (Plate XXVI, fig. 3).

I have on different occasions found ants gathering fallen berries of *Lantana* and carrying them to their nests : *Aphænogaster beccarii* in Coorg, *Myrmecocystus setipes*, and *Camponotus* sp.

Economic uses of *Lantana*.

Were it not for the tendency it has shown of escaping from cultivation, the plant would make an admirable fence and the dwarf varieties would make a very pretty show as permanent flower beds.

In Coorg I have found goats and sometimes cattle feeding on *Lantana*, chiefly on the flowers and the tender flushes ; but at Madhopur, in the Punjab,

and near Haldwani, *Lantana* was found to have the reputation of being poisonous to cattle, especially to those brought down from the Hills.

The wood is often used by the poorer classes as a cheap fuel.

At the Dasara Exhibition at Mysore baskets, purporting to have been made of the split stems and branches of *Lantana*, have been exhibited during the last few years, and presented as good an appearance as those made of bamboo.

I was informed that an essential oil had been extracted from *Lantana* leaves, at the Tata Research Institute, Bangalore, but I have no information as to whether the oil was useful economically, or whether the process of extraction was likely to be cheap enough to lend itself to manufacture on a commercial scale. Mr. R. S. Pearson, Forest Economist at the Forest Research Institute, Dehra Dun, informed me that the extraction of oil had been experimented with at the Institute, but that the extraction was too costly to be a paying concern, even if a demand for the oil were to develop.

I am also informed that immature berries of *Lantana* are, on the West Coast, sometimes put to a use, which neither adds much lustre to the reputation of the plant, nor certainly reflects much credit on the character of the ingenious person who utilizes it, *viz.*, the adulteration of green pepper berries for sale in the market.

Varieties of *Lantana*.

The *Lantana* plant, by reason of differences in the structure of the leaf and the stem and in the colouration of the flowers, is divisible into distinct varieties, and the number of such varieties to be found in India is indeed bewilderingly large.

As a great many of them are garden varieties which are of hybrid origin the work of differentiating, classifying and describing them is a task exceedingly difficult even for an experienced botanist, and is therefore clearly beyond my powers. However, for the purpose of this inquiry, at least a working knowledge of some of the principal varieties appears to be essential in view of the fact that the kinds that have run wild are different in different places, and have evidently been derived from garden forms, and also in view of the fact that at least one insect has shown decided preference to one particular variety.

Bailey in his *Cyclopædia of North American Horticulture* writes: "*Lantanas* have long been in cultivation and it is difficult to refer the garden forms to botanical species. The species themselves are confusing. There are several *camara*-like species which probably have hybridized to produce

Fig. 1. White *Lantana* hedge at Maymyo, Burma.

Fig. 2. *Lantana* hedge (red variety to left and white to right,) at Maymyo, Burma; April 1918.

Lantana varieties at Ramandrug, Bellary District, August 1918; pink (upper left), yellow (lower left), red (centre), pink and yellow (upper right), and pink and red (lower right).

PLATE XXVIII.

these forms ; but Voss, the latest garden monographer, regards these species as only forms of *Lantana camara* (preferring however to use the name *L. aculeata*). Accepting *Lantana* in Voss's sense, the garden *Lantanas* may be said to be derived from that species ; this view is accepted below."

Classification of cultivated Lantanas (Bailey).

A. Plant spiny—fruit juicy.

L. camara Linn. (*L. aculeata* Linn.). Small shrub 1-4 ft. high, etc. ; flowers in a dense nearly flat-topped head, usually opening yellow or pink, but changing to orange or scarlet. Tropical America, extending north to Texas and Granada.

Var. *nivea* (*Lantana nivea*, Vent.). Flowers white, the outer ones becoming bluish ; heads rounder. This is evidently the *white Lantana* noted by me at Coonoor, Wynaad, Lashio, Maymyo, etc. (Plate XXVII, fig. 1 and XXIX, fig. 2).

Var. *mutabilis* (*L. nivea*, var. *mutabilis*, Hook.). Remarkable for the change of colour in the nearly globular heads : in little more than a day the flowers change from white through yellowish lilac, rose and blue. The outer flowers open white, run through yellowish, rose and lilac ; the inner ones open yellowish.

The large-fruited pink variety, found by me at Coonoor and on the Nilgiris generally, is probably this variety.

Var. *mista* (*L. mista*, Linn.). Outer flowers opening yellowish and becoming saffron and brick-red : inner flowers changing to orange.

The beautiful form found around Shillong is probably this variety.

Var. *crocea* (*L. crocea*, Jacq.). Flowers opening sulphur-yellow and changing to saffron. Possibly this is the most common wild form (?).

Var. *sanguinea* (*L. sanguinea*, Medic.). Flowers opening saffron-yellow and changing to brick-red.

Possibly the wild form found by me at Dariaoganj (U. P.) belongs to this variety.

Lantana purpurea, Hornem. Erect : branches hairy with few recurved prickles, etc., etc. : flowers purple, very pretty, in hemispherical, umbellate heads : South America. A form of *L. camara* (?)

The purple varieties found at Bangalore, Coonoor and Madhopur (Punjab) probably belong to this variety.

AA. Plant never spiny : fruit thin-fleshed, usually not juicy.

Trifolia, Linn. (*L. annua*, Linn.). Half shrubby, hairy : leaves in 3's and 4's : heads becoming ovoid or oblong : flowers rosy-lilac, varying to white :

with yellow throat : fruit rather pulpy : Trop. America ; found in gardens sometimes.

Sellowiana, Link and Otto (*L. delicatissima*, Host ?). Weeping or trailing *Lantana* : twiggy slender plant : leaves small : flowers small, in long-stalked small heads, rosy-lilac : S. America.

A very profuse bloomer : *Verbena*-like : the plant seems to be an escape in Florida.

Found by me in Botanical Garden, Rangoon (known as *L. delicatissima*) and in a garden at Lashio. (Plate XXIX)

Involucrata, Linn. Low much-branched bush : flowers small, equalled by the bracts : light lilac or white : Trop. America(cultivated). Not known to me.

Several of the varieties noted by me in various places in India do not fit into any of those mentioned above.

As already indicated above, one of the insect pests noted on *Lantana*, the gall-fly on the flowers (*Asphondylia* sp.), has been found attacking only the orange-red variety of *Lantana*, the commonest of the forms that have run wild, while the one which produces pink and yellow flowers is absolutely free. This gall-fly, on the other hand, breeds freely in flowers of *Lantana indica*. Such a sharp discrimination by the blind instincts of an insect point, in my opinion, to differences more profound than those between ordinary varieties. Very probably the orange-red one is the typical *L.* (*camara*) *aculeata*, while the pink-flowered plant is a distinct species.

However unwelcome the plant may have become owing to its aggressive propensities, the shady side of its character is undoubtedly much relieved by the possession of beautiful flowers. The richness and the variety of colours met with in the flowers, especially in the case of garden varieties resulting from hybridization, are indeed wonderful. The flowers may be pure white in one variety, while in another they may open light yellow with a saffron centre and gradually change into lilac with the centre scarlet. In a third, the recently open flowers are yellow and turn by degrees into saffron and brick-red, whereas in others again the whole cluster may be a rich crimson, a sulphur yellow or a light lilac. When the various varieties are judiciously mixed and kept within bounds by periodical clipping, *Lantana* makes an eminently handsome live fence and the effect produced by the masses of the many-coloured flowers is glorious.

Lantana indica. (Plate XXX, fig. 1.)

It was noted in abundance in the drier regions of the Hills of South India. It was found around Coonoor at Runnymede and Katteri and around Kotagiri, on the Nilgiri Hills, on the eastern flank of the Anamalai Hills, and the greater

Fig. 1. *Lantana delicatissima*.
Lashio, Burma; April 1918.

Fig. 2. White *Lantana* (left) and *Lantana delicatissima* (right);
Lashio, Burma; April 1918.

Fig. 1. Red *Lantana* (left) and *Lantana indica* (right); Sidapur, Coorg, April 1917.

Fig. 2. ***Lantana*** at Sidapur, Coorg, April 1917.

part of the Shevaroys. It was rare on the more rainy portions, as for instance on the western parts of the Nilgiris and the Anamalais and in Coorg and the Wynaad. There seem to be at least three distinct varieties of the plant, so far as observed: (1) growing into tall bushes 3 to 6 ft. high, like *Lantana aculeata*, with purplish flowers, cream-yellow fruits and silver-grey leaves; found on the Nilgiris; (2) stunted plants, generally not forming bushes, with light purple flowers and deep purple generally large-sized fruits; found on the Shevaroys, Coorg, Anamalais, etc.; (3) low-growing shrubs, forming dense clumps, with diminutive leaves and clusters of small white flowers and greenish white fruits (= *Lantana indica* var. *albiflora*); found on the Nilgiris and Masinigudi (Mysore borders).

Though *Lantana indica* is said to be recorded throughout India, I did not come across any specimen in North India except one doubtful case near Kichcha Station in Haldwani District, U. P.

This plant, which is otherwise obscure and inconspicuous, acquires some importance in view of the fact that some of the major pests hitherto noted on *Lantana* also attack this plant, and there appears to be little doubt that it must have served as their original host-plant before they transferred their attentions to its imported cousin.

4. FERTILIZATION OF *LANTANA* FLOWERS.

Lantana is by constitution a butterfly-flower. The corolla tube is cylindrical and elongate and the nectary is situated at the bottom of the tube. The anthers are placed half way up on the sides of the corollary tube, while the stigma lies at the bottom slightly superior to the position of the nectary. The interior of the corolla is armed with a whorl of closely arranged upwardly directed hairs which seem to function as a defence against the entrance of ants and also to serve to prevent pollen-grains from the anthers dropping down onto the stigma.

When a butterfly visits a flower, it unfolds its proboscis and inserts it down the corolla in order to tap the nectary. While the butterfly is thus engaged, it unconsciously conveys a few of the pollen-grains, gathered by its proboscis from the flowers visited just previously, to the stigma and thus causes cross-fertilization. While being withdrawn, the proboscis rubs against the pollen-sacs and gets coated with pollen-grains ready to be conveyed to the neighbouring flower.

In the orange-red variety of *Lantana camara*, the just open flowers are bright yellow and are different in colour from those a day or two older, which

vary from reddish-orange to crimson. The butterflies have been observed invariably to go straight to the yellow flowers and are apparently guided in their selection by the colour sense. There is a corresponding change of

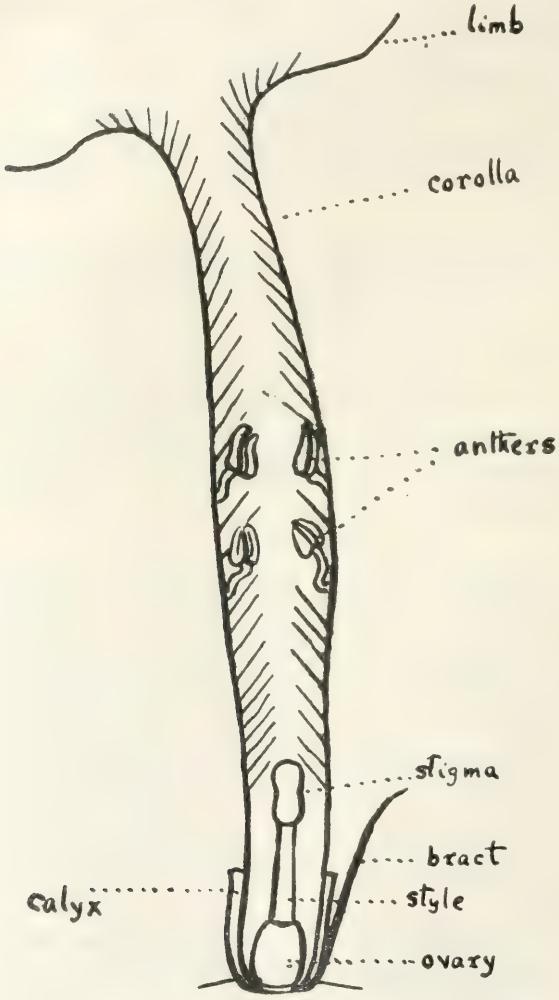


FIG. 3. Longitudinal section of a *Lantana* flower (×7).

colour between fresh blossoms and the spent ones also in the other varieties of *Lantana*, which undoubtedly serves as signboards to the butterfly-visitors.

Though largely favoured by butterflies, *Lantana* is visited by various other flower-frequenting insects, including bees, moths and a few flies.

The following are some of the insects actually noted visiting *Lantana* flowers :

BUTTERFLIES.—

1. *Papilio polymnestor.* Coorg.
2. *Papilio paris tamilana.* Coorg.
3. *Papilio helenus.* Coorg.
4. *Papilio agamemnon.* Coorg.
5. *Papilio sarpedon.* Coorg.
6. *Papilio polytes.* Coorg.
7. *Papilio demoleus.* Coimbatore.
8. *Papilio hector.* Coimbatore.
9. *Cirrhochroa thais.* Coorg.
10. *Cupha placida.* Coorg.
11. *Junonia hierta.* Coorg.
12. *Euplœa coreta.* Coorg.
13. *Hypolimnas misippus.* Coorg.
14. *Danais nilgiriensis.* Yercaud.
15. *Neptis eurynome.* Coorg.
16. *Delias eucharis* Coorg.
17. *Catopsilia pyranthe.* Coorg, Coimbatore.
18. *Curetis thetys.* Coorg.
19. *Yphthima huebneri.* Coorg.

MOTHS.—

20. *Cephonodes picus.* Coorg.
    and *Macroglossum* sp. Coonoor.
21. *Phytometra* (*Plusia*) *albostriata.* Shillong.
22. *Phytometra* (*Plusia*) *orichalcea.* Shillong.
    (21 & 22 were observed visiting *Lantana* flowers at dusk at Shillong in July 1918.)

HYMENOPTERA.—

23. *Apis dorsata.* Ramandrug, Bellary Dist.
24. *Crocisa emarginata.* Londa.
25. *Anthophora zonata.* Barapani (Khasi Hills).
26. *Ceratina hieroglyphica.* Coorg.

FLIES.—

27. *Eristalis* sp. Shillong.
28. *Coryzoneura* (*Pangonia*) *taprobanes:* Gudalur (Nilgiri Hills). This fly was found visiting flowers of *Stachytarpheta indica* in addition to those of *Lantana.*
29. *Thrips.* (2 species.) Throughout India.

At Gudalur (Nilgiris) a tiny bird, probably a species of sun-bird, was observed visiting flowers of *Lantana,* in September 1917.

In March 1917, when I first arrived in Coorg, the season was very dry. Though in some of the less moist parts of Coorg *Lantana* had absolutely dried up, it was quite green and altogether flourishing around Rockhill, near Sidapur.

There was quite an abundance of fruits and a fairly large quantity of flowers. Owing to the dryness of the season, very few insect-visitors were noticeable, there being a notable paucity of butterflies at the time. I was somewhat surprised to find that, in spite of the perceptible scarcity of the common run of insect-visitors, most of the flower-clusters were setting into fruits. An examination of the flowers, however, disclosed the fact that they were frequented by large numbers of Thrips and a detailed inspection indicated that these were actually functioning as agents in fertilization.

There were two different kinds of Thrips noticeable on *Lantana* flowers at the time of these observations. One was a black elongate species of the Sub-order Tubulifera. It was chiefly found living outside the flowerbuds and the flowers. The other, belonging to the Terebrantia, actually tenanted the interior of the corollas. The individuals were of two markedly different kinds, one being dark brown, almost blackish, and the other much smaller and pale yellow in colour. Examination under the microscope showed that the darker individuals were all females armed with a curved, saw-like ovipositor, and that the pale ones were all males. On a few occasions the pale individuals were actually noted courting the darker ones. The minute eggs were laid inside the tissues of the corolla and the young ones, on hatching, crawled about in the interior and fed on the pollen-grains and the nectar, as probably the adult ones also do. Under the microscope numerous instances of young larvæ carrying pollen-grains on their bodies were noted, and it is quite conceivable that they would, while moving down from the anthers to the nectary, deposit a few of the pollen-grains on the stigma, thus causing self-fertilization. It is also probable that the adults, which are able to migrate from flower to flower, carry pollen from one flower to another and thus bring

about cross-fertilization. In this connection, the observations (of the publication of which I was unaware till February 1919) made in America with regard to the prominent part taken by Thrips (*Thrips tabaci*, etc.) in the fertilization of Beet flowers, are of particular interest. (*Bull. U. S. A. Department of Agriculture No. 104*, by Harry B. Shaw).

In order to find out whether *Lantana* flowers can be fertilized by the agency of Thrips alone, the following experiments were devised.

On the 14th March, 1917, as a preliminary experiment, three twigs with unopen flower clusters were selected and enclosed in muslin bags. Before being enclosed, the flower buds were carefully examined to see that all Thrips were entirely excluded from them. In the case of one of the bags (Bag No. 3) adult Thrips collected from other flowers were introduced before being tied up, while the other two (Bags Nos. 1 and 2) remained free from Thrips. When examined on the 20th March, 1917, yellow dots, evidently composed of masses of pollen, were noted on the surface of muslin bag No. 2 at nine different places, in situations where the flowers were adjacent to the muslin, obviously indicating that the bag had received the attentions of a butterfly visitor. Such pollen-masses were not noticed in the case of the other two bags. When examined on the 31st March, 1917, the following results were noticeable.

Bag No.	Nature of experiment	Number of flower-cluster enclosed	Remarks
1	Thrips eliminated	2	Only one fruit had set in each cluster. One of the two clusters had been attacked by the caterpillar of *Platyptilia pusillidactyla*.
2	Ditto	Several flower-heads	Only five (5) fruits were noted in all. A butterfly had evidently visited the flowers, inserting the proboscis through the muslin.
3	Thrips introduced	Several clusters	15, 17, 7 and 15 fruits had respectively set in 4 of the clusters, and in a fifth only 2 had set, the rest having been destroyed by the Plume moth.

These preliminary experiments, though vitiated by the interference of the butterfly visitor, however, indicated sufficiently clearly that Thrips could function as important factors in the fertilization of *Lantana* flowers.

In continuation of these experiments, 10 twigs with unopen flower clusters at the tips were selected on the 5th April, 1917. As before, they were first thoroughly examined in order to free them from Thrips and the eggs of flower-feeding insects, and then enclosed by bags. In five of these, the factor of Thrips was entirely eliminated, while in the rest adult and young Thrips were

introduced, corollas containing the Thrips being bodily transferred in order to give them shelter, until the time when the enclosed flower-heads might open.

The bags were supported by an internal skeleton of brass-wire to prevent them from collapsing. Further, in order to prevent effectively the intervention of butterflies, the wire-skeleton was enclosed inside the bag by a cone of stiff-paper, on which notes regarding the experiments were also entered.

This set of experiments was, however, doomed to be a failure, as owing to the stormy and rainy weather that prevailed at Sidapur between the 7th and the 12th April, 1917, the open flowers both within the bags and outside on the bushes were shed off. Rents were also found in the muslin of some of the bags, owing to their becoming entangled among the *Lantana* prickles of neighbouring branches, when violently swayed about by the heavy winds. The results of these experiments were, therefore, of very little value and are not recorded.

A third set of experiments was taken on hand on the 16th April, 1917. From experience gained from the previous failures, a longer type of bag was adopted, so as to allow for the growth of the branch while enclosed in the bag and prevent the flowers from reaching the muslin cover at the apex. As before, 5 of the bags enclosed flower-heads which had been freed from Thrips, while in the other five Thrips were deliberately introduced. The results of these experiments are shown in the table given below :—

Thrips excluded.

Bag No.	No. of flower-cluster enclosed	Results of examination on 26th April, 1917, and remarks
15	Two flower-heads with unopen flowers.	None of the flowers set into fruits.
16	Ditto	The twig was found to have snapped in the middle and dried up.
17	Ditto	Except in one doubtful case none of the flowers set.
18	Two flower-heads (4 open flowers found in each were plucked off).	One of the flower-clusters had become damaged and had dried up, while in the other none of the flowers had set.
19	Two flower-clusters about to open.	One fruit had set in one cluster and none in the other.

Thrips introduced.

20	Two flower-heads	19 flowers had set in one cluster and 15 in the other.
21	One flower-head only ...	Only one fruit found : the flower-head had been attacked by *Platyptilia*.
22	Two young flower-heads ..	19 fruits in one bunch and 15 in the second.
23	Two young clusters ...	5 in one and 8 in the other.
24	Two very tender flower-heads	3 in one (attacked by *Platyptilia*) and 11 in the second.

Fig. 1. Hill covered entirely with *Lantana*, Mercara, Coorg, May 1917.

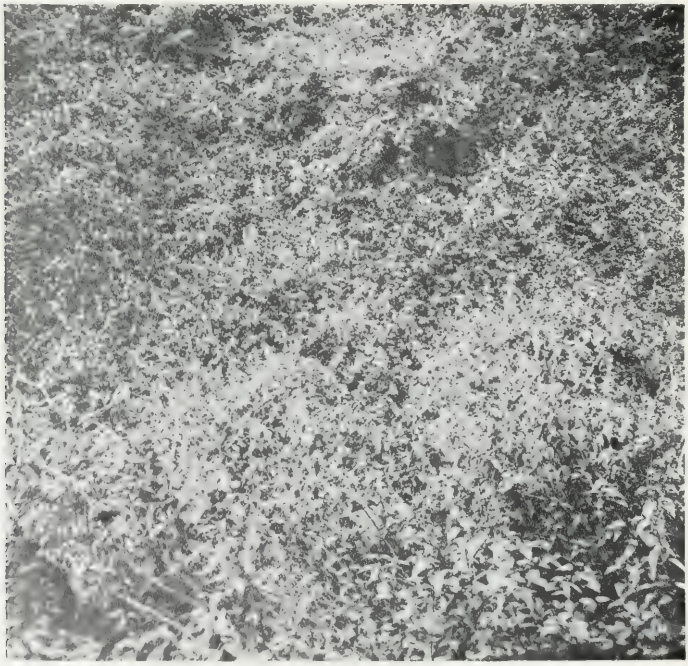


Fig. 2. Hillside covered with *Lantana* at Ramandrug, Bellary District, August 1918.

The results of the above experiments may be summed up roughly as follows :—Where Thrips had been eliminated, only two fruits had set out of seven healthy flower-clusters, whereas, when Thrips had been introduced, 96 fruits had set out of nine healthy flower-heads.

The results of the third set of bagging experiments may therefore be held to be fairly conclusive, though a sufficiently high degree of thoroughness has not been brought to bear on them. For instance, though muslin bags are fairly proof against the ingress of adult Thrips, they are powerless when young larvæ are concerned. In future experiments of this nature, the use of paper bags would seem to be imperative. There appears on the whole very little doubt that Thrips do act as important agents in the fertilization of *Lantana* flowers. In case the introduction of the Agromyzid be decided upon and in case *Lantana* plants with the Agromyzid breeding in the growing fruits are proposed to be brought alive in Wardian cases, Thrips may possibly prove useful in bringing about the fertilization of flowers within the Wardian cases.

5. THE *LANTANA* PROBLEM.

The real magnitude and gravity of the *Lantana* question cannot be appreciated properly until one has visited areas badly infested by the plant. In parts, like Coorg, where the conditions are favourable for its development, the extraordinary luxuriance of growth of *Lantana* is obtrusively evident to the onlooker and extensive stretches of *Lantana* wastes meet the eye on every side, covering hill-sides and filling up the hollows. Dense masses of the weed standing 8 to 10 feet high have taken the place of all low-growing vegetation which is smothered under its heavy shade. (Plates XXX, XXXI.)

Under the dense shade of heavy virgin forests it is usually unable to gain an entrance ; and when it does enter, it exhibits but a weak and lanky growth. The case is altered when a portion of the forest is felled and a clearing made. Before the seedlings of forest trees have had time to grow and fill up the blanks, the *Lantana*, that may already have been there or may have been freshly sown by birds, springs up and in a short time covers the area so thickly as entirely to choke up the saplings and suppress the seedlings. The rejuvenation of the jungle becomes in these cases a serious problem for the Forester. Moreover, the liability of *Lantana* to fierce forest fires renders its entry into the jungle a cause of grave danger, especially when it happens to be of a dry and deciduous character.

Again, owing to its steady encroachment into all open areas, pasture grounds have been becoming more and more limited year by year. The heaviest growth of *Lantana* is usually found in land once cultivated with

coffee but later on neglected and allowed to run to waste, and *Lantana* always exhibits a more luxuriant growth in soil loosened by cultivation because the roots are then able to penetrate it more freely. A dense growth of *Lantana* usually encompasses villages in the Malnad tract and owing to the cover thus offered gives room to the villagers to bring about various insanitary conditions, whereby epidemics like cholera are easily spread. At Chikalda in Berar a thick growth of *Lantana* around the station was believed to have been responsible for certain cases of diphtheria which occurred there in 1893.

Owing to the greater conservation of moisture brought about by extensive sheets of *Lantana* covering up the open places, free drainage of the surface soil is affected and has been considered to lead to an increase of malaria in the neighbourhood. The foliage gives shelter to multitudes of mosquitos and flies, while the large hollow spaces to be found beneath the thick canopy of the interlaced branches of a *Lantana* thicket provide a safe retreat to various noxious animals, such as jackals, porcupines, wild pigs and snakes, and occasionally also to a panther or two and perhaps even to the tiger.

In spite of such an array of evidence as to the injurious nature of *Lantana*, there is an opposite camp that holds that it is really a blessing in disguise. Many of the residents in Coorg, including planters, hold that it functions as an invaluable fertilizer, turning what were mere open wastes, unfit for any cultivation, into rich arable land on which any crop might be grown. By the dense cover it provides, they declare that it wards off the rays of the sun and prevents an undue evaporation of the soil-moisture, and its numerous surface roots are said to prevent soil erosion, while the large mass of shed leaves accumulating on the ground year by year is reported to turn into a rich and valuable humus. To reclaim *Lantana*-ridden land, one has only to cut the *Lantana* down, burn it when dry and then dig out the roots ; the land is then ready for any crop—tea, coffee, or rubber. Besides the humus in the soil, the *Lantana* ash, which is rich in potash, forms by itself a valuable manure, while the land is unquestionably cleared of all weeds and grasses. Under the above circumstances, they consider it a folly to think of eradicating *Lantana*, whereas in their opinion it would be wiser to endeavour to utilize its presence where possible and check its spread where necessary. This view is not confined to Coorg, but is supported by experience in various *Lantana*-infested countries in the Tropics, such as Hawaii, Java, Ceylon and parts of Australia. The general opinion in these islands is strong as to the soil-renovating and the soil-fertilizing properties of *Lantana*, while in an issue of the *Queensland Agricultural Journal*, September 1912 (p. 240) the following definite recommendation is made. "Exhausted sugar lands may

be worked up again, after lying idle for a few years and allowing *Lantana* to grow, which acts as a very valuable green manure crop, accumulating particularly large amounts of potash."

By some people *Lantana* is believed to be a good nurse to Sandal, while others appear to condemn it as the cause of spike in Coorg.

There, thus, seem to be very divergent views as to the economic status of *Lantana*.

Though the soil-fertilizing properties of *Lantana* are generally recognized, the quality of the humus, as compared with what is formed naturally in forests, has been questioned. While it is obvious, as Mr. McCarthy, Conservator of Forests, Coimbatore, stated, that it grows only in humid areas where even otherwise an indigenous vegetation would spontaneously spring up, it does not thrive in dry tracts like Coimbatore, where its soil-enriching powers would be of the greatest value, so that its much-vaunted qualities do not come into play where actually needed.

So far as its relations to deciduous forests are concerned, there would appear to be no doubt as to its injurious nature, and consequently considerable attention is devoted in many of the forests of India and Burma to the eradication of *Lantana*, wherever it has made its appearance.

Methods of eradication.

Neither the agriculturist nor even the planter is affected by the *Lantana* evil, for the few weedings and hoeings that even a careless cultivator will give to his crop are sufficient to keep *Lantana* out of his land. It is only when he neglects these operations continuously for a series of years that *Lantana* is able to take possession of the land, but, when he can command the means, he will always find it easy as well as paying to rid his field of the weed.

The *Lantana* infestation is a problem mainly affecting Forest areas and open waste-lands and grazing grounds. The problem has come into existence in all these cases only owing to the fact that the periodical removal of the plants in the early stages has not been attended to, in the *forest areas* because of the extensive areas concerned, and in the *grazing commons* because nobody in particular attends to them for the simple reason that they are common property.

Attempts have been made at various times to eradicate *Lantana* by mechanical means. People have endeavoured to cut it down and burn it, but have usually found to their sad experience that by the succeeding year a denser and more formidable growth of *Lantana* has sprung up in its place, for not only do the stems and main roots produce shoots in abundance but the

seeds that drop to the ground also get opportunities of germinating. Even when the stumps and roots are dug out, if the destruction of the seedlings that spring up is not attended to for a few years in succession, failure is sure to result.

The real reason of failure in all early attempts was the want of thoroughness in the methods. In Coorg, since 1912, Mr. H. Tireman, Conservator of Forests, Coorg, formulated a scheme which is being systematically followed in Coorg forests for ridding them of *Lantana*. The *Lantana* thickets are set fire to twice or even thrice in the summer during the first year. The stumps are dug out by coolies when the ground becomes soft during the Rains. During the second year, the area is again examined and all regrowth is uprooted and destroyed and at the same time the area is sown with seeds of forest trees. During the third and fourth years, the area is re-examined and all fresh growth of *Lantana* is again destroyed, and by the fifth year the canopy of the young forest trees is thick enough to suppress any regrowth of *Lantana*. The cost was reported to work out at about Rs. 8 or 9 per acre during the first year, R. 1-8-0 during the second year, R. 0-12-0 during the third year and R. 0-6-0 during the fourth. The method is reported to have been very successful.

Previous to the present operations in Coorg, eradication of *Lantana* on a large scale had been tried at Chikalda in the Melghat in Berar. On the plateau around Chikalda, the plant had originally been introduced about 1865 and had covered by 1890 the greater part of the tableland and had extended into the forests along the flanks. Control measures were undertaken in 1893, and between 1893 and 1904, Rs. 27,000 had been spent in uprooting *Lantana* in the Melghat Forests. In 1905, *Lantana* was considered to have ceased to be a trouble and operations were stopped. In 1911–13, however, attention was again devoted to clearing some areas where *Lantana* had again developed. When I examined the area recently, during my visit in January 1919, I found masses of *Lantana* still standing in parts of the forests along the road from Ghatang to Chikalda. Even on the plateau, where *Lantana* destruction had been paid greater attention to, plants were still noticeable in odd corners, growing undetected. This shows how difficult it is to attempt to exterminate *Lantana* in places where it has really overrun the land. Unless the eradication is done absolutely thoroughly and unless the entire area is vigilantly watched to guard against the re-entrance of the weed, all the work done is likely to prove to be labour wasted; for, if left alone, the conditions being the same, the plant is bound to become dominant once again and reassume the original pest conditions.

It is when this aspect of the question is considered that the superiority of the introduction of an efficient natural check over a mechanical method of eradication is forcibly brought to our minds, for the plant is thereby kept under check once and for all, obviating all recurring expenditure.

The importation of another plant to keep *Lantana* in check has been tried in Ceylon. Major Prain refers as follows (in a letter which was published in the *Indian Forester*, XXVII, p. 28), to "a sunflower, *Tithonia*, found in Ceylon where, when it runs wild, it replaces *Lantana*, but Ceylon planters look upon *Lantana* as a blessing and think nothing has done so much to renovate abandoned coffee land, while the sunflower is more difficult to eradicate and exhausts the soil".

Messrs. Tryon and Johnston in their *Report of the Prickly Pear Travelling Commission* mention (page 2) that "Dr. Konigsberger pointed out a peculiar natural enemy of *Lantana*, that occurred in Sumatra, at Deli, and suggested that the occurrence might yield a new outlook in connection with the work. This was a weed belonging to the composite genus *Eupatoria*, which grew with great vigour and literally choked the plant in question". The plant referred to is probably *Eupatorium odoratum*, an account of whose occurrence and alarming spread in Burma and Assam is given under the heading of "other pestilential weeds"; and there is no doubt that, if this be the plant, the remedy is certain to prove worse than the disease itself.

The introduction of the *Lantana* seedfly is a method that is reported to have been successfully tried first in Hawaii and later on in New Caledonia, Fiji and lastly in Queensland. It has been claimed that this method, while not encompassing the destruction of the plant, is definitely able to check its spread and render it possible for one to clear *Lantana*-covered land once and for all without the fear of having to repeat the work every few years.

6. DISTRIBUTION OF *LANTANA*.

(*a*) Factors controlling the Distribution of *Lantana* in India.

Before dealing with the present distribution of *Lantana* in India, the factors which have controlled its spread into the various parts of India may be considered. It has invariably been introduced as a garden plant and, owing to the ease with which it can be propagated by cuttings, has been later on utilized for planting as a live fence around bungalows. Invariably, the starting point has been the city or the big town. From these centres *Lantana* has passed by stages into the country, being carried by visitors from the villages.

In Coorg, it is reported that, in the early days of its arrival, salesmen made a roaring trade by the sale of cuttings, and the countrypeople were said to have clandestinely taken cuttings overnight from the hedges at Mercara and carried them over to their villages. Railway platforms have in many cases, as for instance on the Amritsar-Pathankot Branch, served as nuclei from which the plant has spread. Banks of irrigation canals have in some cases served a similar purpose.

While there are a good many varieties of *Lantana*, which are absolutely sterile or at least produce few fruits, the plant as a general rule seeds extraordinarily profusely. The fruits being edible are eagerly devoured by birds and spread broadcast over the country along with their droppings. Where the climatic conditions are favourable, the *Lantana* seedlings spring up in profusion and by reason of their high vitality soon crowd out all other low-growing vegetation, and form the extremely dense thickets which are common in badly infested parts like Coorg.

Lantana would appear to thrive best only when certain conditions are fulfilled.

The first requisite would appear to be the presence of a large amount of moisture in the soil as well as in the atmosphere. It flourishes well in areas receiving a rainfall ranging from 50 to 150 inches. Very heavy rainfall appears to be prejudicial to its growth, as is evidenced by the paucity of the plants in the *ghat* region in Coorg and at Cherrapunji on the Khasi Hills. Along the long line of the Western Ghats its distribution is extremely interesting. While the low-lying West Coast receives 100–140 inches of rain during the year, the crest of the abruptly rising *ghats* is subject to a rainfall ranging from 150 to 250 inches. On its eastern flanks, the rainfall rapidly falls away and gradually decreases from West to East in the neighbouring uplands of Coorg, the Wynaad, and Malnad. For instance, in Coorg, while near Mercara it approximates 140 inches, at Sidapur it is only 90 inches, and near the Mysore borders it dwindles down to about 40 inches. In the semi-arid tracts of Mysore the rainfall is only 25–30 inches, while in the dry central districts of the Deccan it is barely 20. The relative abundance of *Lantana* closely follows the distribution of the rainfall. While it is most abundant in Coorg, the Wynaad and Malnad with moderately heavy precipitation of rain, in the semi-arid region of the open plateau of Mysore *Lantana* growth is restricted mostly to isolated and stunted bushes spread over the country, and in the arid tracts of Gadag and Bellary it is practically absent.

A similar instance is seen in the distribution in the Punjab. While it is abundant in the submontane districts with 30 to 100 inches of rain, as at

Gurdaspur, Pathankot, etc., *Lantana* is altogether rare in the arid plains of the Central Punjab.

In dry districts, the only places where *Lantana* may be found growing are in moist situations, as around the banks of canals and the margins of tanks and wet-land areas.

The *next desideratum* would appear to be a well-drained soil, a water-logged one being prejudicial to its growth. A striking instance is furnished by a study of the relative distribution of *Lantana* in the Bhabar and the Terai tracts near Haldwani in the United Provinces. "*Bhabar*" (lit. porous) is the name given to a narrow strip of country about 10 miles broad, stretching along the foot of the Himalayas in Kumaon. The soil is composed mostly of fine earth mixed with stone and gravel, forming part of the *debris* washed out when the uplift of the mighty Himalayan Range occurred. The soil is extremely porous and all the water drained out from the hillsides is reported to sink to an unknown depth and re-emerge as natural springs in the low marshy tract of the "*Terai*" lower down. Whereas the "*Bhabar*" is extremely well-drained, indeed to such an extent that wells are unknown in this tract, the "*Terai*" is completely water-logged.

In the "*Bhabar*", inadvertently introduced at Kathgodam about 30 years ago by an Engineer, it has spread through the country like wildfire, entering the jungle, and invading pasture-grounds and open waste-lands; whereas in the "*Terai*" comparatively small quantities are to be seen in favourable situations, and apparently *Lantana* has no chance at all of spreading in that marshy jungle, the home of the tiger and tall giant grasses.

In Coorg, again, it is only the well-drained slopes of the hills and the ridges that are *Lantana*-ridden, while it is scarce in the marshy hollows lower down.

Thirdly, *Lantana* does not seem to be able to bear great extremes of temperature. Frost and snow as well as dry scorching heat appear to be inimical to its growth. On the Nilgiris, the growth of *Lantana* stops at a height of about 6,400 ft.; at altitudes of 7,000 ft., as at Ootacamund, subject to frosts, it is practically absent. It is reported that *Lantana* has spread into the Chamba valley in the Punjab Himalayas, where snowfall would appear to be common, but I have no idea of the actual conditions, as I had no opportunity of visiting it.

Lastly, *Lantana* is a lover of sunshine, though not of too much of it. Shade is prejudicial to its growth and it has absolutely no chance of thriving under the leaf canopy of thick forests. When, however, a clearing is made in the forest, *Lantana* quickly occupies the open spaces and prevents its natural regeneration.

(*b*) Distribution of *Lantana* in India and Burma.

South India.

As regards the distribution of *Lantana*, Southern India may be divided roughly into three distinct regions :—

1. *The Western Ghats region*
2. *The Central region* consisting of the Mysore Plateau and detached hills like the Shevaroys, Ramandrug Hills, etc.
3. *The East Coast Littoral.*

1. *The Western Ghats region* is by far the most important of all. The Western Ghats are a very long chain of Hills, extending north to south for nearly 1,000 miles from Khandesh to Cape Comorin. The range varies in height from 2,000 to almost 8,000 ft. and generally rises abruptly from the lowlands of the West Coast. Along its eastern flank, the range slopes more or less gradually until it merges into the plateaus of the Deccan, Mysore and the Nilgiris. South of the Palghat gap there is, even on the Eastern flank, a sudden drop from a height of 3,000 ft. or more to the lowlying plains of the southern districts of Madras. *Lantana* is noticeable in abundance all over the lowlands of the West Coast and increases as the foot of the hills is reached, but on the steep western face of the range and along the elevated crests, fully exposed to the influence of the monsoon currents, very little of *Lantana* is to be found. Due partly to the heaviness of the rainfall and partly to the presence of evergreen forests, *Lantana* does not appear to spread there.

To the north of the Nilgiri Hills, there extends, along the eastern flank of the Western Ghats, a distinct belt of heavily wooded, upland area, consisting of a confused tangle of ridges and hollows, which includes the Province of Coorg, the Wynaad taluq of Malabar, the Gudalur taluq of the Nilgiris, and the tract known as "Malnad" (lit. hilly country) in Mysore and South Bombay (Plates XXX, XXXI). It is in this area that *Lantana* attains its heaviest developments and is seen at its worst. It is also in this tract that the problem of *Lantana* control is felt the keenest and its solution is of supreme importance. As the "Malnad" gradually passes into the open uplands of Mysore, *Lantana* also becomes less and less abundant, until at last in the open country only isolated stunted clumps are seen.

The Nilgiris. Where *Lantana* has been able to effect an entry, it is noticeable in abundance below an altitude of about 5,000 ft. ; 3,000-4,000 ft. appears to be the optimum height for it in the Nilgiris, as is evidenced by the quantities found around Gudalur and Hillgrove and Runnymede. A heavy growth is

also noticeable at Kallar, at the foot of the hills. At Coonoor, large masses are observable, but as one travels higher up the plateau, *Lantana* is noticed to become less and less abundant, until at some distance above Aravankad (6,200 ft.) it entirely disappears. *Lantana* is absent at Lovedale and Ootacamund (where the only representative is a pink plant struggling for existence in the Botanical Garden).

At Kotagiri (6,500 ft.) only three straggling plants were found after much search, but three miles lower down along the Mettupalayam Ghat Road, *Lantana* begins to appear and is found increasing in abundance as one travels down. Along the Ootacamund-Gudalur Road, the first specimen of *Lantana* is noticed near Naduvattam (6,000 ft.). It becomes plentiful below an elevation of 5,000 ft. While on the plateau the red and the pink varieties are both present, along the flanks the red one greatly predominates.

The Anamalais. The Anamalais are a confused mass of hills, rising abruptly from the plains of the Coimbatore District and breaking up westwards into high ranges and deep valleys, all clad with heavy primeval forest. The lower elevations are covered with valuable forest, containing teak, rosewood, bamboo, etc., while the higher altitudes contain magnificent evergreen or "*Shola*" forest. A great part of this "*Shola*" forest has been cleared of recent years and planted with tea, coffee and cardamoms.

In the teak forest area around Mount-Stuart, *Lantana* was plentiful chiefly along the sides of the forest tramline but even in the interior of the forests numerous plants were noticeable, showing, however, only poor and lanky growth for want of sunshine. On the Punachi side of the Anamalai Hills, *Lantana* was on the whole rather scarce, but in a portion of the tea forest area about two miles from Attakatti, it was extremely abundant, being reported to have migrated from the adjoining Waterfall Estate, in which *Lantana* had been cultivated as a hedge-plant and where large fences still line the cart-road. Further up, in the interior of the Anamalai Hills, *Lantana* was noticed only around Iyerpadi, no trace of the plant being noticeable anywhere else in the planted area.

I have had no opportunities of examining the Western Ghats region, south of the Anamalais, but from information derived from the Forest Department, *Lantana* would appear to be plentiful on the Palni Hills, and around Ambasamudram and Srivilliputur, and on the Courtallam Hills in the Tinnevelly District.

2. *The Central Region.* *Lantana* is common throughout the State of Mysore, though it is only in favourable situations, as for example around Tumkur, that it shows an extraordinary luxuriance of growth.

In Bangalore it is a common and favourite hedge plant and is also commonly noticeable in waste-lands as an escape from cultivation.

At Horsleykonda—4,100 ft.—in the Chittoor District, masses of *Lantana* are reported to be noticeable.

On the Shevaroy Hills, in the Salem District, *Lantana* is reported to have been introduced about thirty years ago by Mr. Dixon Carter as a rare garden plant from Bangalore. Since then it has gradually spread until at the present time it has become so common that it is difficult to find an open place unoccupied by it anywhere around Yercaud. Fortunately, however, *Lantana* is at present noticeable only for a few miles around Yercaud, and several places such as Nagalur, Vallakadai and Kaveri Peak are still free from it, and coffee-planters in these places are vigilantly guarding against its introduction into their area. It is the pink variety that has spread around Yercaud, but the red one is also noticeable a few miles off.

Ramandrug is a small Hill Station, 3,500 ft. high, situated on a narrow plateau on the crest of the Sandur Range in the Bellary District. About forty or fifty years ago *Lantana* appears to have been introduced as a rare hedge plant from Bangalore and planted around one of the bungalows. Since then it gradually and imperceptibly increased, till it spread into the forest and covered extensive areas on the tops and sides of the hills (Plate XXXI, fig. 2). Though the dominant variety is the red one, pink, yellow and mauve varieties are also observable.

Near Erode, the red variety of *Lantana* was found growing in some abundance along both sides of the railway embankment towards the Cauveri Bridge.

3. *The East Coast littoral.* The only area on the east coast that was examined by me was the tract around Madras. It is the pink variety chiefly that is noticeable in this area and is observable in fair abundance along the banks of the Buckingham Canal, along the sea beach in places and along lanes in Nungambaukum and Mylapore. *Lantana* appears also to have extended some miles to the south and the west along the railway lines. Being situated in an area subject to the heavy rains of the North-East monsoon, Madras appears to be an area favourable to the growth of *Lantana.*

Chicacole Road was the only other place where I noticed *Lantana* along the line of the East Coast Railway.

Travancore, Cochin, the Palni Hills, the Courtallam Hills and Hyderabad are some of the tracts that I had no time to visit.

Bombay.

Dharwar, Londa and Castlerock were the only places visited by me in the Bombay Presidency, but *Lantana* would appear to be present in

great abundance around Belgaum and Poona. I have noticed it growing in some quantity at Lonavla, Igatpuri and Nasik Road along the Railway line and in the neighbourhood of Bombay. Mr. T. N. Jhaveri, Entomological Assistant, Bombay, informed me that *Lantana* hedges are common at Surat and Baroda.

Owing to want of time, a visit to some of these places in Bombay had to be dropped out of the programme.

Dharwar is only on the fringe of the rainy "*Malnad*" tract and *Lantana*, therefore, occurs as scattered stunted bushes in open areas : but it grows into dense thickets in favourable situations such as around irrigation reservoirs and margins of streams. To the west of Dharwar, *Lantana* increases in quantity and masses of the plant are noticeable near Kambarkanve and at Londa.

Castlerock is a small station, 2,000 ft. high, situated in the very rainy Ghat region on the borders of the Portuguese territory, and in this place *Lantana* was absolutely non-existent, though it was very abundant at Londa only 16 miles away from Castlerock. *Lantana* was not noticeable also along the West Coast line from Castlerock up to Sanvordem.

A few plants were noted at Gadag station in the arid black soil tract east of Dharwar.

Burma.

Lantana appears to be, on the whole, a recent introduction in Burma, though at Rangoon itself it must have been existing for the last forty years at the least.

Though largely supplemented by personal observations, much of the information regarding the local distribution of *Lantana* in Burma was derived from the files of the Forest Department, for which I am much indebted to Mr. C. G. Rogers, Chief Conservator of Forests, Burma.

(1) *North Burma.* *Lantana* appears to be confined to gardens in private compounds and the heavy teak forests are quite free from this weed.

(2) *Central Burma and the Shan States.—Pyinmana.* Though found in some quantity on the dry gravel ridges found within municipal limits of the town, *Lantana* has not entered the teak forests close by, being separated from them by stretches of rice cultivation.

Lantana bushes were, however, noticeable along the Railway line, for some dense thickets were noted around the Railway Stations at Swa and Kyadaunggon.

Mandalay. Confined to gardens.

Maymyo. Found extensively cultivated as a live fence around bungalows in this Hill Station. It has escaped from control at Anisakan about 10 miles from Maymyo. (Plate XXXII, fig. 1.)

Lashio. Found grown as a fence around many of the bungalows and showing tendencies of escaping from control.

Kalaw (Southern Shan States). None noted, but *Lantana* was reported to have been seen in some of the Shan villages. I was informed by Mr. Wright, Forest Officer at Kalaw, that *Lantana* had been noted in the fruit gardens about six years ago at Loi-An, but had been destroyed since then.

(3) *Tenasserim Forest Circle.* Reported to be very bad in the neighbourhood of Pyu in Toungoo Division and appears to be spreading from the railway up and down the main floating streams.

At Moulmein, *Lantana* was noticed spreading along the sides of the ridge, close to the precincts of the Chief Pagoda there ; a few plants were noted also around an old Buddhist monastery.

Masses of *Lantana* were also reported to be noticeable at Tavoy.

(4) *Pegu Forest Circle.* (Pegu, Henzada and Arakan.)

Pegu. Lantana was found growing among hedges around Bungalows.

Rangoon. Chiefly noted grown as a live fence, though in some places it was noticed as an escape from cultivation. Noted also at Insein and along part of Railway line to Prome.

Henzada. A small quantity was reported from unclassed forests in that Division.

Arakan. According to Mr. Rogers, " The lilac-coloured *Lantana* was introduced into Paletwa in the North Arakan Hill Districts, about 20 years ago, by the Deputy Commissioner, Mr. W. Hildebrand. It has spread a good deal on the cleared hills around the station and has also found its way down the Kaladan River, where it is fairly common in the forest near the River."

Also known to be abundant at Akyab.

Information regarding the existence of *Lantana* in Arakan and at Pyu was obtained rather late and I could not find time to visit these areas. Besides these two, the only places where *Lantana* was found in abundance and where there was real danger of spreading was around Maymyo and Anisakan.

At Maymyo a veritable craze for *Lantana* fences was noticeable. On every side and in every lane *Lantana* meets the eye. The fences were extremely pretty, being composed of several distinct varieties bearing flowers that offered a striking contrast in their colours. It was however clear that it was only the orange-red variety that seeded profusely and on that account was the only really harmful one. The others were either absolutely sterile or

Fig. 1. *Lantana* hedge bordering compound of Club at Maymyo, Burma, April 1918.

Fig. 2. *Lantana* covering a slope at Dehra Dun.

produced fruits very sparingly. Mr. C. G. Rogers, Chief Conservator of Forests, was of opinion that there was not much danger in *Lantana* hedges if they could be properly clipped at intervals, for it was only when they were neglected that they ran to seed and become a source of danger. From inquiries made, *Lantana* appears to have been introduced into Maymyo about twenty years ago, but considering the length of time it has been there, it is rather amazing that it has not spread more widely than it has done actually. It is plain, however, that it has escaped into the open and entered the outskirts of the jungle, but evidently it has not yet assumed the dimensions of a pest. At Anisakan, only a few miles off, on the other hand, though introduced only 10 or 12 years previously, it has already assumed a seriously aggressive form and shows a very vigorous growth. According to Mr. C. Dixie Kiernander, who is farming in that area, this luxuriance of growth is attributable to the effects of the desultory cultivation of the Shan tribes, who, following very primitive methods, burn a piece of the jungle, dig out the roots of trees, and after ploughing and reploughing the land, raise crops of paddy, sesamum, beans, potatoes and pine-apple in the course of two years, only to leave it fallow for the next seven or eight years. The soil, having been thoroughly loosened in this manner, has proved a happy nursery for *Lantana* escapes.

Assam.

For information regarding the distribution of *Lantana* in Assam, I am indebted to Messrs. Tottenham and Blunt, Conservators of Forests, Eastern and Western Circles respectively, and to Rai Bahadur Upendranath Kanjilal, Retired Extra Deputy Conservator, to whom my thanks are also due for his kindness in naming numerous plants collected in Shillong.

Lantana appears to be at present scattered in small patches throughout Assam, both on the Hills and in the valleys of the Brahmaputra and the Surma. It is, however, on the Khasi Hills around Shillong that it is found in largest quantity.

Sibsagar. Reported to occur sporadically throughout the Division and not yet to be a menace to forests as it chiefly occurs in old cultivation.

North-East Frontier. Lantana not common.*

Nowgong. Not plentiful.

Lakhimpur. Found scattered, not plentiful.

Sylhet. Found in some quantity.

Kamrup. Large patches of *Lantana* were seen along the Railway line and in the town at Gauhati.

* It occurs plentifully around Dibrugarh and at Margherita, but does not seem to have reached Dum-Duma or Sadiya. [T. B. F.]

Khasi and Jaintia Hills. Found in quantity in several villages around Shillong. Large patches of *Lantana* were noticed by me at Barapani, 9 miles below Shillong, and larger sheets of the same two miles further down the road to Gauhati.

Small patches of *Lantana* were found also at Cherrapunji, some on sites of old houses ruined by the earthquake; but, owing to the incessant rains, *Lantana* does not appear to be flourishing there.

At Shillong efforts seem to have been made since 1906 to keep *Lantana* in check, and within the limits of the Municipality destruction of *Lantana* in compounds has been made compulsory by law. In spite of these attempts to check it, *Lantana* is still to be found in fairly good numbers on hill sides and under pine trees.

In Assam, I was able to visit only Shillong, Gauhati and Cherrapunji. The rest of the province could not be examined for want of time.

Bengal.

Prain in his "Bengal Plants" remarks that *Lantana camara* occurs in the Central and Eastern portions frequently and in the Western portions only occasionally naturalized.

With the exception of Calcutta, I have not had the opportunity of visiting any part of Bengal, but in the following places *Lantana* was found in plenty along the Railway line from Howrah to Mokameh.

(1) Around Madhupur Railway Station, (2) Around Raniganj Railway Station, and (3) numerous *Lantana* bushes were noticeable along the E. I. R. line between the 9th and the 16th miles-stones from Howrah.

Lantana was noted cultivated in some of the gardens at Calcutta.

Bihar and Orissa.

Pusa was the only place examined by me in this Province.

A few *Lantana* plants are noticeable near the Pusa village growing in odd corners of uncultivated land.

Chota Nagpur. According to the *Forest Flora of Chota Nagpur, Lantana* occurs occasionally semi-naturalized in Chota Nagpur, as for example around Chorparan.

Orissa. *Lantana* hedges are reported to be common at Cuttack.

The Punjab.

Mr. R. N. Parker in his *Forest Flora of the Punjab, Hazara and Delhi,* makes the following remarks :—"It has obtained a footing near Madhopur,

Chamba and Sabathu, and is often seen in hedges in the Palampur Tahsil, Kangra District, and in Hoshiarpur. The plant has become a pest in parts of the Deccan and much has been written against it. In places which suit it, it grows in dense impenetrable thickets. If it could be got to grow in the Hoshiarpur Siwaliks or in the sheltered ravines of the Pabbi Hills, it would be very useful. In cultivated plants, flowers of all colours from cream to yellow, crimson and purple are found and the colour is frequently variable in the same head. Flowers more or less throughout the year."

Along the Amritsar-Pathankote line, *Lantana* was noticeable around the following stations :—Dhariwal, Sohal, Gurdaspur, Dinanagar, Sarna and Pathankote. At Gurdaspur, *Lantana* was noted growing as a hedge around several of the bungalows. Around the Railway Station at Sarna, very dense patches of *Lantana* were noticeable and it is evident that the platform gardens have along this line served as nuclei from which the weed has spread all round. Madhopur is a small village, 9 miles from Pathankote, whence the Ravi Canal commences. The sides of the canal and especially an elevated patch of waste land to the right of the canal road are covered by impenetrable thickets of *Lantana*. *Lantana* was found plentiful along the canal road as far down as Sujanpur (4 miles off), whence the road branches off to Pathankote. Whereas at Gurdaspur and Sarna, the red variety of *Lantana* was the commonest, it was entirely replaced around Sujanpur and Madhopur by varieties bearing pink, yellow and mauve-coloured flowers. The soil at Madhopur was a porous gravel composed of shingles and detritus washed down from the neighbouring hills and the nature of the soil in combination with a heavy rainfall has conduced to the development of a heavy growth of *Lantana*.

Lantana was common as a hedge-plant around compounds and fields at Hoshiarpur, where escapes in fairly large numbers were noticeable in waste-lands and around neglected hedges. At Amritsar, a few plants were noted growing around some of the fruit gardens, and at Lahore the only specimens of *Lantana* that could be found were certain ornamental varieties grown in Public Gardens.

Mr. G. R. Dutt, who worked in the Punjab during my absence on leave, examined Sialkot and Jhelum but did not find any *Lantana* growing wild in those places.

It was unfortunate that Palampur in the Kangra Valley and Chamba had to be left out on account of want of time, as a study of *Lantana* growth in such mountainous situations, where the climatic and physical conditions are so peculiar, would have been of great interest.

Owing to the extreme dryness of the climate, *Lantana* is very unlikely to spread in the plains of the Punjab, but in sub-montane tracts along the foot of the Hills receiving a good rainfall there are great possibilities of its assuming the status of a serious pest.

United Provinces.

The following information regarding the distribution of *Lantana* in the United Provinces was obtained at the Forest Research Institute, Dehra Dun.

"*Lantana* present in masses around Haldwani in Terai and Bhabar Government Estates."

"Found either cultivated or spreading as a weed in Lucknow, Jhansi, Lalitpur, Cawnpur, Gorakhpur and Kalpi."

The following places were visited by me in the United Provinces :— Dehra Dun, Masuri, Kathgodam, Haldwani, Nainital, Lucknow, Gorakhpur and Cawnpur.

Both at Dehra Dun and at Kathgodam, the soil, being formed mostly of detritus washed from the hills, is very porous, and owing to their situation at the foot of the outer Himalayas, these places are subject to a heavy rainfall (125 inches being received at Dehra Dun). The conditions are therefore very favourable for the spread of *Lantana*.

At Dehra Dun, *Lantana* hedges composed of several different varieties were noticed around some of the compounds ; *Lantana* was also noted spreading along the banks and sometimes in the dry beds of some of the *nallahs* in the neighbourhood. Especially was this the case in the case of one of the large dry water-courses known as the Rispana *nallah*, on the eastern bank of which numbers of self-sown seedlings of *Lantana* were observed growing under the shade of young mango trees in neglected plantations. (Plate XXXII, fig. 2.)

Kathgodam and Haldwani, which are only 4 miles apart, are both situated in a tract of country known as the *Bhabar* (lit. porous), which, as already explained, is composed of gravelly soils and is extremely well-drained. All the rain-water washed from the hills is reported to sink to an unknown depth and to be completely absorbed. The soil is so porous that wells are unknown in this area. *Lantana* is reported to have been introduced into this tract about thirty years ago by Mr. Doherty of the P. W. Department, in charge of the canals. First planted round his garden, step by step it spread all round until at the present day it is found occupying most of the waste-lands and the pasture grounds and large portions of the jungle. Near Kathgodam, dense thickets of *Lantana* were noticeable at the very base of the hills, up the sides of which also they were noted to extend for some distance. (Plate XXXIII.)

Fig. 1. Side of canal at Kathgodam, U. P., covered with *Lantana*, December 1918. Note the stony nature of the soil.

Fig. 2. Waste land overgrown with *Lantana* at Kathgodam, December 1918.

Along the Kathgodam-Nainital Road, *Lantana* was noted in good quantity for a distance of two miles, beyond which it was not noticed, though a mile nearer the Brewery a few stray plants were found by the road-side. *Lantana* was not noticed at Nainital, but it was reported that at Almora, about thirty miles farther into the interior of the hills, it was known to exist. Around Haldwani, it was the orange-red variety that had run *amok*, though pink-flowered bushes were also noticeable among the hedges.

In the Terai area, further down, which is badly water-logged and covered by giant grasses, *Lantana* is noticed in very much smaller numbers, some patches being noticeable near the Railway Stations of Lal-kuah and Kichcha.

Lucknow. Masses of *Lantana* were noticeable on both sides of the O. and R. Railway line bordering the cantonment. Here the land is undulating and broken up into rounded slopes and small water-courses. Originally planted around some of the compounds, it has strayed into this favourable well-drained area and has grown into dense thickets.

Gorakhpur. Being part of a moist and lowly situated area liable to floods, Gorakhpur is not a likely place where *Lantana* could spread. However, in several parts of the town, *Lantana* hedges are common and in one of the public parks *Lantana* was found growing freely on rockeries and small embankments ; and stray seedlings were observed under the shade of trees in the Park as well as in the immediate neighbourhood. The *Sal* forests in the vicinity were examined but are evidently too dense to allow of the intrusion of *Lantana*.

Cawnpur. As at Lucknow, *Lantana* was found running wild in somewhat undulating land, as for instance at Nawabganj, where it was noticed forming thickets in neglected garden compounds and in sparse jungle. It was also noted running wild in compounds in the city. It was rather remarkable that even in public gardens, *Lantana* was being allowed to flourish as if it were a rare ornamental plant, in spite of the fact that the plants were seeding profusely.

The B. B. & C. I. line from Cawnpur to Agra was, at the suggestion of Mr. Leake, Principal, Cawnpur Agricultural College, examined as far as Darnagganj. *Lantana* was observed growing on either side of the Railway line up to Maudhana. Masses of *Lantana* were noticeable around the following stations : Rawalpindi, Kalianpur, Chaubepur, Bilhaur, Fatehgarh, Kaimganj and Rudain and in special abundance at Maudhana and Darnagganj. At Darnagganj where inquiries were made, it was reported that *Lantana* had been introduced about sixteen years ago as a live fence around the platform. The soil around the station is a sandy loam, favourable for *Lantana* and, owing to the abundance of birds, which were found greedily feeding on the fruits, the

plant has become rapidly disseminated and is now abundant all around the station for a distance of a mile. Here is a second instance of a Railway line being the starting point for the spread of *Lantana*.

The Central Provinces.

The following notes regarding the distribution of *Lantana camara* are found in Witt's *Descriptive Botanical List, North and Berar Forest Circles, Central Provinces*:—

"Common in the upper slopes of the Melghat; hilly localities in Buldana; waste-land near villages—Nimar (Chanda); not uncommon as a hedge—Saugor, Jabbalpur, Hoshangabad (Pachmarhi)."

Jabbalpur, Nagpur, Ellichpur and Chikalda in Melghat were the only places visited in the Central Provinces.

Jabbalpur. With the exception of a few stray plants growing among the hedges in the town, *Lantana* is non-existent at Jabbalpur.

Nagpur. *Lantana* of the pink variety was noted in some quantity growing wild around the Maharajbagh Farm and along the sides of the *nallah* running through the Park. Hedges were also found along the Railway embankment near the station.

Ellichpur. The red variety was noted in hedges around some of the fields and also on the sides of the large water-course running through the town.

Chikalda and Melghat. I am indebted for much of the information regarding the distribution and spread of *Lantana* in Melghat to office notes by Mr. Kenny, Deputy Conservator of Forests, Amraoti, whom, however, I could not meet personally.

Chikalda is a small hill station, situated on the top of a plateau, 3,500 ft. high, belonging to the Mahadeo Range of the Satpura Hills; it is also the chief town of the Melghat Taluq, and the summer headquarters of the Commissioner of Berar. *Lantana* appears to have been introduced about 1865 as a garden plant and planted as a hedge around bungalows and along roads and lanes, at Chikalda. Later on, it is reported to have been carried into the villages by the *gaolis* and by the Forest subordinates, and also to have been planted as a border fence along the newly constructed Ghatang-Chikalda Ghat Road about 1882. *Lantana* flourished exceedingly and rapidly encroached on the ground it was planted to protect, and through the agency of birds, it got distributed throughout the plateau and penetrated deep into the forests.

"In the early nineties," in the words of Mr. Kenny, "it is understood that much of the plateau was overgrown. This was undesirable from a sanitary point of view and is believed to have been responsible for certain cases of

diphtheria which occurred about 1892-93. At the same time, the dense growth in the ravines near Chikalda was found to have overtopped the natural trees, many of which were completely suppressed. It was decided that *Lantana* should be got rid of and work was started in 1893-94."

About 28,000 Rupees appear to have been spent towards the eradication of *Lantana* in the forests, between 1893 and 1905 and between 1911-1913.

According to Mr. Kenny, "*Lantana* has spread a good deal and is now fairly common in a great part of Sembadeh and in the Kharda and Khalsa villages and also around Hatra. It is to be seen everywhere in Chikalda range and in the eastern part of Gugumal. Much or most of the dense growth is found in forest which contains little teak. No serious damage to valuable forest is now taking place and it is unlikely that any regular operations will be found necessary."

I found a good deal of *Lantana* growing scattered in open places and also in the jungle all along the road from Ghatang to Chikalda. In favourable situations, as in moist depressions and along sides of ravines, masses of *Lantana* were noticeable. Even on the top of the plateau, where *Lantana* destruction had been carefully attended to, plants were noticed growing undetected in odd corners.

7. INSECTS FOUND ATTACKING *LANTANA* IN INDIA.

(*a*) Conditions under which the Inquiry was conducted.

The object of the present deputation was, in the words of the orders of the Government of India "an inquiry into the efficiency of the existing indigenous pests as a check on the spread of *Lantana* in India."

If any really effective insect enemies had already become evolved in any part of India, the fact would have been of such importance to people in areas infested by *Lantana*, that it would hardly have failed to attract their notice. The quickness, for instance, with which the fact of the outbreak of *Orthezia insignis*, the "*Lantana* Bug," in 1891 in Ceylon, and recently in the Barwood Estate in the Ouchterlony valley in the Nilgiris in 1915, became known is clear proof of the view that the presence of an effective insect on *Lantana* is not likely to be overlooked by the people affected.

It was, however, considered neither improbable nor impossible that there might exist unnoticed in some corner of the vast Indian continent an insect that might show definite tendencies towards combating the aggressiveness of *Lantana* and promise to give excellent results, when transported to

localities with more favourable climatic conditions. It was with this object in view that a thorough examination of all the *Lantana* areas in India was undertaken.

Though in certain tracts like Coorg, the presence of *Lantana* is almost offensively evident and the inhabitants cannot possibly afford to ignore its existence, there are, on the other hand, quite a number of places in India and Burma, where happily *Lantana* is either altogether non-existent or confined to fences around some of the bungalows, or only found growing stray as a garden escape. For purposes of the present investigation, it was not considered sufficient to restrict the examination of *Lantana* to areas where it is rampant and where, as evidenced by the luxuriance of its growth, the plant is not obviously being kept in check. The localities where the plant is not much in evidence are as interesting and probably of even greater import ; for though the paucity of *Lantana* in a particular place may, in many cases, be due to the unfavourable nature of the climate or the soil or possibly be accounted for by the recentness of its introduction, yet there is always the possibility that such particular locality may prove to be the Eldorado sought for, where the spread of the plant has been effectively checked by insect agency.

It is therefore imperative, if the inquiry were to be really thoroughly done, that as few of the places as possible where *Lantana* was known to be present should be omitted from visiting, but there were several limiting factors which stood in the way of a proper prosecution of the inquiry. Firstly, there was no definite information ready at hand in regard to many of the Provinces, as to the local distribution of *Lantana*, and some time had to be wasted by visiting the responsible local officers for acquiring the required knowledge. Secondly, in some of the places visited, the plant was not even recognized and I had laboriously to search it out myself. Thirdly, the time at which a particular locality is visited has a great deal to do with a proper examination of *Lantana*-feeding insects. For every tract there is a particular time when insects are found in greatest abundances and, if it be missed, few of them may be noticeable. The fact that I found very few insects on *Lantana* in a country so rich in insect life as Burma is perhaps to be attributable to my having visited that province in the dry weather, while an almost similar experience was the result of my visit during the cold weather to the Punjab, United Provinces, and the Central Provinces. Though the optimum period for each province varies owing to different climatic conditions, yet within certain limits this period is synchronous for most of the provinces, so that if the best results are desired, the inquiry will have to extend for a series of years. But, as the

period of deputation was more or less limited to about two years, the work had to be rushed through and in consequence has not been thorough in several respects.

Owing to want of time again, several tracts have had to be omitted entirely, such as Travancore and the extreme South of Bombay, Gujarat, Chota Nagpur, and Bengal.

However, what was really needed to be known was, whether there was at present existent in India any insect capable of acting as an effective check on *Lantana*, especially an indigenous insect of the nature of the seed-fly of Mexico introduced into Hawaii. If such an insect were really present in India the fact would, irrespective of the time of visit, easily have forced itself on my attention, for, even if it did not occur throughout the year, sufficient traces of its presence were bound to have been noticeable even in the most adverse part of the year. Hence, the knowledge that has been gained in regard to this question, though imperfect owing to the many gaps that have to be filled in, is sufficient to indicate the absence of any really effective pest to keep *Lantana* in check.

(b) Insects noted feeding on *Lantana* in India.

As may be evident from the list of insects given below, a fairly large number of insects have been noted on the *Lantana* plant in India and there is little doubt that the list might have been longer yet, if other parts of India had been examined and if some of the parts actually visited could have been examined at the right time of the year. Of the insects listed below, a great many were noted only once or twice, and in some cases only solitary specimens were observed, so that it was obvious that these were only casual visitors on *Lantana*, but as, in a great many cases, they were actually found feeding on the plant or might be presumed to be injurious to it from the very nature of their mouthparts and their feeding habits in general, they could not be discarded as unimportant insects, especially as it was considered not unlikely that, under different and more favourable conditions, they might occur in such numbers as to function as a check on *Lantana*.

The order followed in the arrangement of the families, in the list given below, is somewhat arbitrary, especially among the Lepidoptera. In this case, however, the Pterophoridæ and the Microlepidopterous families have been taken up first, as they were considered to be more important than the rest of the Lepidoptera as checks on *Lantana*.

LEPIDOPTERA.

Family Pterophoridæ.

1. *Platyptilia pusillidactyla*, Wlk. (Plate XXIV). It is one of the most efficient of the insects on *Lantana* in India. It chiefly feeds on the flower-buds and the flowers, thus checking the formation of fruits. The fruits are also attacked, especially the unripe ones, which the caterpillar hollows out and causes to turn prematurely black. The mature fruits are also bored into, but the real embryos, which are protected in special pockets of the hard shell, are not affected.

The tiny egg (Figs. 2, 3), which measures $\frac{1}{3}$ mm. $\times$ $\frac{1}{6}$ mm., is laid singly on the unopen flower-buds and sometimes also on the corollas of open flowers and on tender leaves. It is ellipsoid in shape and shiny opalescent-yellow in colour. The surface is rough, being covered with an irregular network of ridges. The egg hatches in four days. The young caterpillar bores into the base of one of the unopen flowers and attacks the ovary first and then the pollen-sacs. The adjacent flower-bud is next attacked in a similar way, the entrance being effected by tunnelling at the base (Plate XXXIV, fig. 1). Each caterpillar is able to destroy at least 15 to 20 of the flowers in a flower-head, and as it moves on from flower to flower, the line of its progress is marked by the shallow tunnel which it gnaws out of the surface of the flower axis. The full-grown larva (fig. 6) is about 5 mm. long, stout, bright yellow, and smooth. When mature it prepares a silken cocoon which is lodged in an enlarged part of its tunnel on the flower axis and covered over with the dried fruits or flowers (fig. 8). The pupa (fig. 9) is slender, elongate, cylindrical and yellowish-brown in colour; the hinder abdominal segments are armed dorsally by two pairs each of rather stout backwardly-directed spines, with the aid of which the pupa pierces the thin cocoon and, wriggling half-way out, allows the moth to emerge. The moth (fig. 11) has been recorded from all parts of India, Burma, and Ceylon, and is apparently a cosmopolitan insect having an almost world-wide distribution. It was evident, however, that it was not present in Hawaii, since it was one of the insects imported from Mexico and it is also clear that it is not to be found in Queensland since Mr. Tryon proposed in 1912 to import this moth along with the Agromyzid from Hawaii. [Outside of the Indian Region, it is known from the West Indies, Mexico, South America, Seychelles, Reunion, Hongkong, and Hawaii.—T. B. F.]

In India and Burma this insect was noticed by me feeding on *Lantana* both on the Hills and in the Plains in all the areas except the Punjab, where

Fig. 1. *Lantana* flowers attacked by caterpillars of *Platyptilia pusillidactyla*; Gorakhpur, December 1918.

Fig. 2. *Lantana* fruits webbed by *Lobesia* sp.; Kathgodam, U. P., December 1918.

it was conspicuous by its absence, but it is possible that its absence at the time of my visit in October was due to the cold weather having already set in.

This plume-moth also breeds in flowers and fruits of *Lantana indica* and *Lippia geminata*. The latter is an introduced American plant that has become acclimatized in parts of North-Eastern India, while the former is an indigenous species with a wide distribution covering the whole of tropical Asia and Africa. The widespread occurrence of its native foodplant easily accounts for the wide distribution of this moth in the Indian Region. The usefulness of this insect in checking the spread of *Lantana* is greatly minimized by the fact that it is subject to the attack of several parasites, one of which attacks the eggs and the others the caterpillars.

In Coorg I have noticed a small black Vespid with a narrow yellow band on its abdomen, *Icaria* sp. (near *aristocratica*) (T. V. Ramakrishna Ayyar det.) ripping open the cocoon of this plume-moth and carrying off the pupa.

Family Eucosmidæ.

(2) *Lobesia œolopa*, Meyr.

(3) *Lobesia genialis*, Meyr.

Both these species are found attacking the flowers and fruits of *Lantana*. The moths are extremely alike, so that it is difficult to distinguish* the one from the other, but the caterpillars are quite distinct.

The eggs are small, flattened and irregular in outline and hatch in about four days. They are laid singly on the tender leaves, on the flowers and on the fruits. The caterpillars of *Lobesia genialis* are green or yellowish-green, with the head marked by a lateral streak and the prothoracic shield bordered with black except anteriorly; while those of *Lobesia œolopa* are dark brown with prominent yellowish white shields carrying hairs. The head is shiny black while the prothoracic shield is dark brown with a tinge of yellow.

The caterpillars web up the flowers and the fruits and feed on them. In the case of mature dry fruits they feed on the dry pulp and also partially bore into the seeds but do not damage the embryos. (Plate XXXIV, fig. 2.)

When mature they pupate generally in a fold of the leaf and the moth emerges in about eight days.

Lobesia œolopa, Meyr., is known to occur in Ceylon, Cape Colony, and Reunion. In Ceylon it has been recorded to breed on *Cajanus indicus* and has been bred from flowers of *Leucas* sp. at Pusa.

* The female moths are practically indistinguishable, but the males cannot be confused. [T. B. F.]

I have noticed both the species generally occurring together in most of the places where they have been noted, but *Lobesia genialis* was invariably the commoner of the two.

In South India *Lobesia* was noticed in plenty around Coimbatore, at the base of the Nilgiri Hills, and in Bangalore. It is less plentiful on the hills and in Coorg, Wynaad, and the Malnad of Mysore. It has not been noted on the Shevaroy Hills.

In Bombay it was noted in good numbers around Dharwar. In the United Provinces I noticed it only around Kathgodam where it occurred in fairly good numbers.

It is undoubtedly one of the more important insects on *Lantana*, but very rarely occurs in sufficient numbers.

4. *Argyroploce erotias*, Meyr. The caterpillars were on three different occasions collected feeding on *Lantana* flowers. The pupa is characterized by the presence of a pair of pits on the dorsal surface of the second abdominal segment.

Loc. Kallar and Bangalore.

5. *Argyroploce aprobola*, Meyr. Caterpillar collected feeding on *Lantana* flowers only on one occasion at Kallar, Nilgiris.

Family Tortricidæ.

6. *Cacœcia epicyrta*, Meyr. The caterpillars, which are cylindrical and vary from a light green to a dark brown in colour, web up adjacent flower heads and feed on the corollas, but are sometimes found also on shoots or on ripe fruits boring into the seeds but not injuring the embryos. The pupa of this species may be distinguished from that of allied forms by the first dorsal ridge of the abdominal segments being medially indented posteriorly to form a re-entrant angle.

This species was bred by me on *Lantana* at the following places :—*South India*: Coimbatore, Kallar, Bangalore, Sidapur, Manantoddy, and Yercaud; *United Provinces*: Dehra Dun; *Central Provinces*: Nagpur; *Burma*: Pyinmana.

It is a useful insect but hardly occurs in sufficient numbers to be effective.

7. *Homona menciana*, Wlk. The cylindrical, stout, greenish or yellowish caterpillar may fold the leaves at the tip of *Lantana* branches or web up the flowers and flower buds. The pupal period lasts about a week.

Collected from Kallar, Sidapur, and Vayitiri.

8. *Homona coffearia*, Nietn. Bred on one occasion from *Lantana* at Sidapur.

9. *Adoxophyes privatana*, Meyr. The larva webs up leaves and flowers of *Lantana*, pupates in a fold of the leaf and emerges in about eight days.

Loc. Coimbatore, Kallar, Manantoddy, and Coorg.

10. *Planostocha cumulata*, Meyr. Noted once at Kallar.

Family Pyralidæ.

11. *Ephestia* sp. ? (unidentified). The flattened eggs are laid on the fruits, and the slender cylindrical caterpillars, which are marked by faint pink stripes, web up the fruit-clusters and feed on the dry pulp of the mature fruits. The kernel of the seeds is sometimes also eaten into, but their germinating power is not destroyed, the embryos not being reached.

Rarely flowers and tender leaves also are attacked.

Loc. Coimbatore, Mettupalaiyam, Bangalore, and Sidapur.

12. *Ephestia*? sp. A caterpillar, similar to the above but larger, was collected feeding on dry *Lantana* fruits. The moth which emerged was much larger and appears to be a distinct species.

Loc. Kathgodam, U. P.

Family Arctiadæ.

12. *Diacrisia obliqua*, Wlk., var. *confusa*. Moths with the abdomen and the hindwings and sometimes also the forewings tinged with crimson.

In January 1917 several batches of young caterpillars were noticed at Bangalore. I am indebted to Mr. Kunhi Kannan of the Mysore Agricultural Department for the following information. Early in October 1917 when a bad outbreak of *Diacrisia obliqua* had been reported at Hawal near Mysore on horsegram, cowpea, beans and *ragi*, it was observed that the caterpillars, after devastating the crops, had invaded the *Lantana* hedges and practically defoliated the bushes. When I visited the same village on the 28th October 1917, and examined the hedges, I noticed that the bushes, though they showed clear evidences of having suffered from the caterpillars, had put forth fresh shoots and had thoroughly recovered.

This caterpillar was noted feeding on *Lantana* leaves and flowers in the following localities :—Bangalore, Jan. 1917 ; Hawal (Mysore), Oct. 1917 ; Sidapur, Mercara (Coorg), Nov. 1917 ; Wynaad, Nov. 1917.

13. *Diacrisia obliqua*, Wlk., var. *todara*. Moths :—Males with abdomen and hindwings tinged with crimson and females with abdomen orange and wings buff.

Caterpillars found feeding on *Lantana* in small numbers in Coonoor, and Gudalur (Nilgiris), and in Yercaud (Shevaroys).

14. *Diacrisia flavens*, Moore (1879) ♀
Diacrisia eximia, Swinh. (1891) ♂

The male moths are reddish-yellow while the females are ochraceous and possess an anal tuft of buff colour.

The eggs are laid in close clusters on leaves and covered over with buff-coloured hairs. The number of eggs laid is quite large, ranging between 300 and 400. The egg is pale yellow in colour, smooth, shiny, and spherical.

In one instance, a female moth was noticed on 1st Nov., 1917, resting on the upper surface of a *Lantana* leaf at Sidapur, Coorg. Under its abdomen two eggmasses were noticeable, one larger than the other, and evidently they must have been deposited the previous night, 31st October–1st November. The eggs hatched on the 9th November, 1917, so that the egg stage appears to have covered in this case about nine days.

Out of a batch of caterpillars which hatched on 19-20th March, 1917, one was reared apart from the others. It cast its first moult on 24-25th March, second on 30-31st March, third moult on 5-6th April, fourth moult on 12-13th April, fifth moult on 18-19th April, and sixth moult on 25-26th April. It prepared a cocoon about the 2nd and pupated on 3-4th May. The moth emerged on 29-30th May, 1917.

The young caterpillars are gregarious up to the third instar and feed on the green matter of the leaves, reducing them to thin parchment. From the fourth instar they appear to drop off from the bushes and disperse, only stray individuals being noted, feeding either on the flowers or the leaves and sometimes on the fruits. The full-grown larva is 18–20 mm. long, dark brown in colour, the head and the prothoracic shield bright yellow. The segments carry dorsally pairs of large bright indigo-blue tubercles bearing bunches of dark brown setæ. Long grey hairs are also borne dorsally on the meso- and the meta-thorax and on the first, seventh, eighth and ninth abdominal segments.

In breeding cages the caterpillars prepared cocoons of silk, hairs and earth on the surface of the soil provided at the bottom. The pupa is thick-set, dark purplish-brown in colour and is $6\frac{1}{2}$ to 8 mm. in length. The moths emerged in about two to three weeks after pupation, the emergence being observed to occur usually late in the afternoon.

It also breeds on *Diospyros montana* in Coorg. It has been noted in Coorg, the Wynaad, and the Anamalais.

Though noted in fairly large numbers at times, it is not much of a check on *Lantana*.

15. *Diacrisia indica*, Guer. Larva very similar to *Diacrisia flavens* (=*eximia*), but the head is reddish, the prothoracic shield is bright metallic

blue-black, and the dorsal shields carry a central bunch of three or four black spines and a peripheral circlet of short yellowish spines.

This species was noted feeding on *Lantana* at Mercara in Coorg and at Yercaud in the Shevaroys.

16. *Diacrisia* sp. (*lubricipeda* ?). A stray caterpillar collected at Coonoor.

17. *Pericallia ricini*, Fb. A few caterpillars were noted on *Lantana* at Gudalur (Nilgiris), September 1917.

18. *Amsacta albistriga*, Wlk. Hairy caterpillars, presumably of this species, were noted in some numbers on *Lantana* along the road between Hunsur and Mysore in July 1917. Moths could not be reared out.

19. *Creatonotus gangis*, Linn. A specimen of this moth was reared out from a caterpillar collected on *Lantana* at Coonoor in December 1916.

20. *Celama internella*, Wlk. The egg is circular, slightly flattened and finely sculptured and greenish-yellow in colour. The caterpillar is greyish-brown with a median dorsal whitish-yellow stripe. The lateral tubercles on the three thoracic and the seventh abdominal segment are bright orange-red. Only four pairs of suckerfeet are present. The larva feeds on the flower-heads and when full-fed builds a torpedo-shaped cocoon of strips of bark and the *Lantana* prickles spun up with silk. The moth emerges in about eight to nine days.

Loc. Coimbatore.

Hampson remarks that this species feeds on the fleshy sheets of *Rubus*, but spins in the open (*Fauna of Br. India*, Moths, Vol. II).

21. *Celama fasciata*, Wlk. Caterpillars were collected at Kallar (Nilgiris ; 1200 ft.) (Dec. 1916) feeding on *Lantana* flowers ; in appearance and habits similar to *Celama internella*.

The larva bears a very striking resemblance to that of *Euproctis scintillans*, but can be distinguished by the presence of only four pairs of suckerfeet. Pupal period in December ten or eleven days.

22. *Chionama peregrina*, Wlk. Bred from a caterpillar found on *Lantana* flowers at Nadavanda (Mysore State), October 1917. The caterpillar builds a beautiful open cocoon out of its hairs.

23. *Asura rubricosa*, Moore. Bred from pupa found on *Lantana* leaf at Coimbatore.

Family Eupterotidæ.

24. *Eupterote* sp. Found in large numbers on *Lantana* bushes at Coonoor, Nilgiris, in December 1916.

25. ? *Eupterote* sp. Found in small numbers on *Lantana* leaves in Coorg and the Wynaad.

26. ? *Eupterote* sp. Found in small numbers on *Lantana*, Anamalai Hills.

All the above three *Eupterote* caterpillars were noted on *Lantana* but none of them could be reared into moths. None of them is very important.

Family Lasiocampidæ.

27. *Trabala vishnu*, Lef. Noted in very small numbers on *Lantana* in Coorg, the Wynaad, and the Anamalais.

It feeds on *Rubus* spp. in the Nilgiri Hills.

Family Lymantriadæ.

28. *Olene mendosa*, Hb. A brown and grey hairy caterpillar, carrying a pair of anteriorly directed tufts of grey-brown hairs and a median dorsal backwardly-directed pencil of brown hairs on the seventh abdominal segment ; it feeds on the flower-heads of *Lantana*. It has been found in moderate numbers in most places in South India both in the Hills and in the Plains. It is a very useful species, as each caterpillar is able to account for the destruction of at least ten flower-heads, but it is never found in large numbers and is subject to the attacks of parasites. It is a minor pest of cultivated crops.

29. *Euproctis scintillans*, Wlk. Hairy caterpillars found feeding on the flowers both in the Hills and in the Plains in South India.

In North India I have noted it at Dehra Dun.

The larvæ feed exclusively on the flower-heads and would form a fairly efficient check on the seeding of *Lantana* if they were present in large numbers. It is, however, a pest of several cultivated crops and is freely attacked by parasites.

A single specimen of *Euproctis fraterna* was reared, feeding on flowers at Gorakhpur.

30. *Euproctis flavinata*, Wlk. Caterpillar :—trunk brown : head brown : anterior tufts grey : first and second abdominal hair-cushions brown surrounded by a yellow circlet : third abdominal cushion grey : posterior tufts, the mid-dorsal line and the anal tuft grey. Found in some numbers feeding on *Lantana* flowers at Sidapur, Coonoor, Gudalur, Pudupadi, Yercaud, etc.

31. *Euproctis* sp. Kallar : bred from caterpillar feeding on flowers. Moth with a dot on forewing.

32. *Euproctis flava* and *E. digramma*. Both were captured as adults resting on *Lantana* leaves, Sidapur. Possibly their larvæ feed on *Lantana*.

33. *Orgyia postica*, Wlk. Caterpillars on *Lantana* in small numbers at Bangalore.

It is also a pest on crops.

34. *Porthesia xanthorrhœa*, Koll. Caterpillars attacking *Lantana* flowers at Bangalore, January 1917.

35. *Leucoma subvitrea*, Wlk. Bred from a single caterpillar found on *Lantana* leaf at Mount Stuart, Anamalai Forests, December 1917.

Family Noctuidæ.

36. *Hypena* sp. (near *abyssinialis*). Eggs greenish, flattened and sculptured, laid singly by side of the veins on under-surface of *Lantana* leaf. The caterpillar, when full-grown, is about 18 mm. long, and is light green with numerous small dot-like shields carrying moderately long black setæ. There are only four pairs of prolegs. A caterpillar that hatched on the 3rd December, 1916, prepared its cocoon on the 22nd December, pupated on the 23rd December, and emerged on the 2nd January, 1917. The larvæ feed on the green parenchyma of the leaves, the portions eaten into turning into conspicuous whitish blotches. They also feed largely on flowers and sometimes on fruits. A single caterpillar may destroy several flower-heads. Pupation occurs generally in a fold of the leaf. This species also breeds on *Lantana indica* and *Lippia geminata*.

Loc. Found in most places in South India, abundantly at Bangalore and Coimbatore. It was noted in small numbers at Gurdaspur in the Punjab. Traces of its presence were noted in many places in the United Provinces and the Central Provinces. In Coorg it was found to be kept in check by Tachinid parasites.

It is especially abundant just after the Rains.

37. *Eublemma abrupta*, Wlk. Eggs yellow, shiny, hemispherical; surface pitted and armed with numerous tiny capitate processes: $\frac{1}{2}$ mm. in diameter: laid among the flower buds.

The caterpillar is a true semilooper with only three pairs of prolegs. The general colour is a dark velvet-brown variegated with patches of black and bright yellow. The larva presents a bizarre appearance owing to the presence of 5 or 6 pairs of prominent black clubbed hairs borne on wart like shields on the anterior segments of the body. These clubbed hairs are not present in the newly hatched caterpillar but appear in the third instar. Pupation occurs in a cocoon built of silk and excreta. The larval period varied from 9 to 15 days while the pupal stage may last 12 to 21 days. In one case eggs collected on 12th May, 1917, hatched on 17th May, 1917, at Sidapur.

Loc. Noted at Coimbatore, Kallar, and Sidapur (Coorg). Found usually in small numbers, but the caterpillars feed largely on the flower-heads and sometimes eat into immature fruits. According to Moore's *Lepidoptera of Ceylon* this species feeds on *Ficus parasitica* in Ceylon.

38. *Eublemma silicula*, Swinh. The eggs are more or less spherical, minutely sculptured and armed with numerous tiny clubbed hairs and are ½ mm. in diameter. The larva is a true semilooper, somewhat hairy, yellowish-brown with darker patches. It lives among the flower clusters or the fruit-bunches, surrounding itself with a light silken webbing, and feeds from within. I have reared it on *Lantana* only at Coimbatore in South India and at Haldwani and Kathgodam in the North. It usually breeds in earheads of *Sorghum* in South India.

39. *Agrotis c-nigrum*, Linn. A large cluster of yellowish small spherical eggs about 90 in number, found deposited on a *Lantana* leaf, was collected at Runnymede, Nilgiris, on the 30th December, 1916. The eggs hatched on the night of the 1st January, 1917, and the larvæ, after undergoing four moults, pupated in mud cells between the 6th and the 10th January and emerged between the 24th February and the 4th March, 1917.

The caterpillars fed freely on *Lantana* leaves in the cages.

40. *Heliothis obsoleta*, Fb. Caterpillars of this cosmopolitan insect were noted feeding on *Lantana* flowers on different occasions at Mercara and Bangalore.

FAMILY GEOMETRIDÆ.

41. *Hemithea* sp. (near *tritonaria*). Egg yellowish, elliptical in outline, rather flattened, somewhat resembling a miniature cake of Pears' soap in shape; laid singly on the corollas of flowers.

The caterpillar is a dark brown looper, which masks itself dorsally with bits of flowers and other dead plant tissues attached by silken threads to peculiar anchor-shaped spines found on its body. It feeds on the flowers and pupates in a loose cocoon formed of rubbish spun together with silk. A caterpillar which hatched on the 2nd December, 1916, pupated on the 3rd January, 1917, and emerged on the 15th January, 1917. Another which hatched on the 8th December, 1916, pupated on the 3rd January, 1917, and emerged on the 14th January, 1917. The pupal period varies from 9 to 13 days.

The adult is a prettily coloured moth of a light green colour.

Loc. Coimbatore, Bangalore, and Yercaud.

42. *The small Geometrid* (not identified). Eggs are small, oval, slightly depressed, and yellowish in colour. The caterpillar varies from a pale yellow

to a dark brown in colour, the sides striped with pale brown. The caterpillar is very slender and is about 12 mm. when full-grown.

The larval period varies from 10 to 12 days while the pupa takes 9 to 11 days to emerge. The moth is yellow-brown marked with brown undulations.

The caterpillars feed on the florets and have been found in fairly good numbers in places. Noted at Sidapur, Coimbatore, the Wynaad, the Nilgiris, etc. Noted also in Burma, at Shillong in Assam, at Kathgodam, Cawnpur, and Nagpur (?)

43. *Biston suppressaria*, Gn. A larger looper found feeding on *Lantana* leaves at Kallar, December 1916.

44. *Hyposidra talaca*, Wlk. A large yellow-brown looper found feeding on *Lantana* leaves at Coimbatore.

45. *Boarmia bhurmitra*, Wlk. A looper feeding on leaves; Yercaud, August 1917.

Family Hypsidæ.

46. *Argina syringa*, Cram. Caterpillars of this species were found feeding on *Lantana* leaves in January 1917. Pupation occurred in fold of leaves.

Loc. Bangalore.

Family Sphingidæ.

47. A *Sphingid*. Eggs were noted on *Lantana* leaves at Sidapur in April but, being parasitized, did not hatch. Mr. F. Hannyngton, I.C.S., then Commissioner of Coorg, informed me that he had noted a Sphingid breeding on *Lantana* in Coorg during the rains.

Family Psychidæ.

48. *Clania crameri*, Westwood. The larvæ live in tough cases of silk overlaid by an armour of bits of dry twigs. They have been found in small numbers feeding on leaves at Coimbatore, Sidapur, and the Wynaad. The male moths are winged while the females are wingless and live in the larval cases.

Family Arbelidæ.

49. ? *Arbela tetramis* (probably). In the hilly upland tracts of Gudalur (Nilgiris), the Wynaad, and Coorg, the branches and sometimes the stems of *Lantana* were, in certain localities, attacked by an Arbelid caterpillar, which retreated into a central tunnel during the daytime and fed on the live bark at night under cover of a gallery of silk and bits of bark and excreta. The affected branches exhibited symptoms similar to those of the bark-fungus noted

in the same area. The leaves gradually turned red and the whole branch ultimately dried up. Moths could not be reared out.

At Shillong *Lantana* twigs were noticed to have been attacked in a similar way by a similar Arbelid caterpillar, but it is not possible to say if it is identical with the above, as moths were not bred out. The caterpillar was parasitized by a Tachinid. Branches of a species of *Rubus* were similarly attacked at Shillong.

FAMILY LYCÆNIDÆ.

50. *Zizera gaika*, Trim. In March 1917, a solitary caterpillar of this species was found feeding on immature *Lantana* fruits at Sidapur, Coorg. No other example of this caterpillar was found later. It is interesting in view of the fact that there are two Lycænids in Mexico that feed on *Lantana* flowers and fruits. The butterfly was kindly identified for me by Mr. F. Hannyngton, I.C.S., until recently Commissioner of Coorg.

According to Bell (*Jour. Bombay Nat. Hist. Soc.*, Vol. XXV, p. 443), this butterfly breeds in the flowers of *Nelsonia campestris* (Acanthaceæ) in Kanara.

The larva was about 7 mm. long, flattened, more elongate than broad, light green with several grey-margined stripes of violet colour. The body was thickly covered with close-set short feathery hairs. Hindmost segment flattened, possessing a pair of white papillæ.

It pupated on the 17th March and emerged on the 24th of the same month.

COLEOPTERA.

FAMILY MELOLONTHIDÆ: SUB-FAMILY CETONIANÆ.

51. *Protœtia aurichalcea*, F.;

52. *Oxycetonia versicolor*, F.;

53. *Anthracophora crucifera*, F.

These three species of Cetoniad beetles were found attacking *Lantana* between November and January. They bite into the base of the axis of the flower-heads and appear to feed on the juices that exude from the injured parts. They have been observed to remain clinging to the bases of the flower axis for hours together, without making the slightest movement during the whole time. The axis of maturing fruits may similarly be attacked. Affected flower-heads are completely destroyed.

These beetles also attack earheads of *Sorghum* and feed on the milk of the developing grains.

Loc. Noted on *Lantana* at Coimbatore in South India and at Dharwar in Bombay (September 1918).

Sub-family Melolonthinæ.

54.....(not identified). This small beetle was found feeding on the flowers of *Lantana* in small numbers in June 1918 at Shillong. It was noted in much larger numbers on rose flowers.

Sub-family Rutelinæ.

55. *Popillia birmanica*
56. *Popillia cupricollis*
57. *Anomala variivestis*

} Found feeding on *Lantana* flowers, Shillong, Khasi Hills.

Family Meloidæ.

58. *Zonabris phalerata*. Anamalai Hills, Dharwar, Gauhati, Barapani (Khasi Hills).

59. *Zonabris* sp. Bangalore.

60. *Zonabris cichorii*. Found at Gauhati and at Barapani (Khasi Hills; 3,000 ft.).

These blister-beetles were found feeding on *Lantana* flowers in small numbers. Though these beetles are plentiful at Coimbatore, it was remarkable that none were noticed going to *Lantana*.

Family Curculionidæ.

61. *A small weevil*, resembling *Baris neelgheriensis* but smaller, black with a few yellowish dots, was found in numbers at Bangalore in July 1917 frequenting the flower-heads of pink *Lantana*. They ate small holes into the bases of the corollas, but it was evident that they were not engaged in ovipositing. Most of them were found in pairs.

62. *Baris neelgheriensis*. One solitary specimen found on a flower-head at Coonoor, August 1917.

63. *Myllocerus delicatulus*. On leaves in small numbers at Yercaud; it was also noted on *Lantana indica* in the Shevaroys.

64. *Myllocerus viridanus*. Coimbatore; in small numbers on leaves.

65. *Phytoscaphus triangularis*. Noted on *Lantana* leaves at Lucknow, December 1918.

66. *Sympiezomias subfasciatus*. On *Lantana* leaves; Katteri Road (Nilgiris).

Family Scolytidæ.

67. *A small Scolytid* was found attacking the dry portions of twigs killed by the bark fungus in Coorg and the Wynaad. The beetle bores tunnels into

the wood and lays eggs, the grubs hatching from which would apparently seem to continue their work. (Plate XXXV, fig. 3.)

Possibly there are two species concerned—one larger than the other. The specimens have been sent to Mr. C. F. C. Beeson, Forest Zoologist, Dehra Dun, for favour of identification.

Family Bruchidæ.

Several Bruchids (including *Bruchus* spp. and *Spermophagus* sp.) were on different occasions noticed among *Lantana* flowers, on which they presumably feed; but they were generally found in very small numbers and are of very little importance.

DIPTERA.

Family Cecidomyiadæ.

68. *Asphondylia* sp. (probably * *sesami*, Felt). The *Lantana* gall-fly is a small dusky-coloured fly which appears to be nocturnal in habits. The female possesses a long stylet-like ovipositor which is completely retracted into the body when not in use; the young flower-buds would appear to be pierced by the stylet and the eggs then laid among the pollen-sacs inside. The maggot feeds on the pollen-masses and causes the formation of the gall which resembles a large unopen flower-bud in most respects except for a peculiar bulge in the middle. When full-grown it turns into a pupa, the cephalic end of which is armed with a set of short stout spines, which are used by the pupa for boring its way partly out of the gall so as to enable the fly to emerge. In a small number of cases the fly also attacks tender fruits, the maggots having been observed to feed inside the berry. The affected fruits are easily distinguished by their elongate-oval shape. (Plate XXXV, figs. 1, 2.)

These galls have been found mostly in the hilly tracts belonging to the Western Ghats ranges in the Indian Peninsula. They have been collected in Coorg, the Wynaad, Gudalur and Kallar (Nilgiris), the Anamalais, Malabar (Tamarasseri, Pudupadi and Calicut), Dharwar and Londa in Bombay, Sagar in Mysore, and the Ramandrug Hills in the Bellary District. They have not been noted in the Plains nor at Bangalore and Tumkur nor in the Shevaroy Hills.

At Nagpur some of the *Lantana* bushes exhibited a curious malformation of the flowers. The corollary tubes of the diseased flowers were stunted and

* Dr E. P. Felt has since informed us that the *Lantana* Cecidomyiad is quite distinct from *Asphondylia sesami*. A description of the *Lantana* gall-fly will be found in Vol. VII, part 1, of these Memoirs. [T. B. F.]

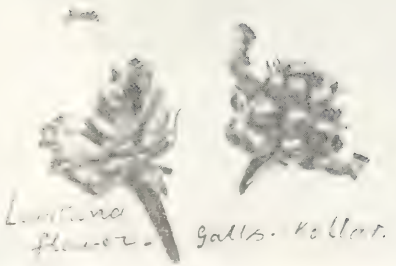


Fig. 1.

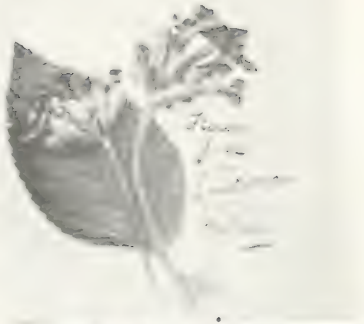


Fig. 2.

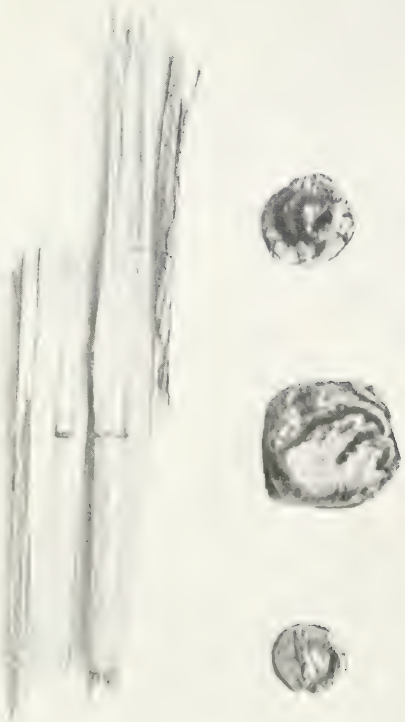


Fig. 3. Sections of *Lantana* stems attacked by a Scolytid beetle in Mysore.

PLATE XXXV.

bulged and irregularly developed, showing a somewhat striking resemblance to *Lantana* galls, although in these cases the flowers had opened. In most cases the pollen-sacs were found damaged, though traces of any insect were not noticeable. Young unopen buds were also examined under the microscope and in three cases a small maggot of the Cecidomyiad type was noted among the pollen-sacs. Getting information from Mr. J. L. Khare, Entomological Lecturer, Nagpur, of the occurrence of galls in *Sesamum* I collected the galls from the Farm fields and was able to rear the adults of *Asphondylia sesami* from them. The undoubted occurrence of this fly at Nagpur when coupled with the cases of malformed *Lantana* flowers noted above is of peculiar significance in relation to the question of the identity of the *Lantana* gall-fly.*

This gall-fly is undoubtedly beneficial to a certain extent, as in favourable seasons a large percentage (nearly 30%) of the flowers may thus be attacked. Generally only 2 to 7 flowers out of 25 or 30 in a cluster are transformed into galls, though in one case as many as 16 were noted in a cluster of 25.

The usefulness of the fly is very greatly diminished by the fact that it is heavily parasitized, at least three Chalcidids and a Braconid having been reared out from these galls.

These flower-galls have been noted also on *Lantana indica* in Coorg and in the Nilgiris.

Flies have been reared out and are presumably identical with the *Lantana* gall-midge. It was somewhat surprising to find that, at high elevations (5,000–6,000 ft.) in the Nilgiris, galls occurred only on *Lantana indica* to the exclusion of *L. camara* though the red variety of the latter was plentiful. At 3,000 feet galls were found in both.

It was also interesting to note that these galls are observable only on the red variety of *Lantana camara*. None have been noted on the pure pink variety, though in two or three solitary cases galls were noted at Gudalur and in Coorg on pink hybrids.

If this fly proves to be identical with *Asphondylia sesami*, Felt, which is a fairly bad pest on *Sesamum* and clusterbeans at Coimbatore, it will be an insect which one should be careful about introducing into other places.*

FAMILY DROSOPHILIDÆ.

69. .....(not named). This fly was found breeding in good numbers in the pulp of the large-sized fruits of a pink variety of *Lantana* which I noticed around Coonoor in the Nilgiris. The seeds were unaffected.

*See, however, footnote on page 292.

An Ortalid fly (*Ceroxys* sp.) was bred out from fruits of *Lantana indica* collected near Kotagiri, and a *Mycetophilid* from the fruits of the same plant near Sidapur.

ORTHOPTERA.

Family Acridiidæ: Sub-family Pyrgomorphinæ.

70. *Orthacris acuticeps*, Bol. This is a wingless grasshopper which has been found attacking the flower-buds and the flowers around Coimbatore, Bangalore, Madras, Hebgod (Mysore State) and Ramandrug (3,500 ft.).

71. *Orthacris ruficornis*, Bol. This is another wingless grasshopper which is restricted to the Hills of Southern India and has been noted on *Lantana* in the Nilgiris, the Shevaroys and the Anamalais. The Nilgiri variety is a metallic bluish-green while the one found in the Shevaroys and the Anamalais is a metallic light green. Large numbers were noted on *Lantana*, both the adults and the young ones feeding freely on the leaves and the flowers. Some of the hedges in the neighbourhood of Coonoor were found badly attacked in August 1917. The grasshopper, however, disappears after September. It also feeds on *Dodonæa viscosa* on the hill sides near Coonoor.

72. *Aularches miliaris*, L. In Coorg, the young ones hatch in April from eggs laid in the soil the previous year and feed gregariously on almost any plant they find growing near by. Large numbers of the young ones were noted on some of the *Lantana* thickets near Rockhill, Sidapur, and some of the bushes were almost entirely defoliated by them. As they grew bigger they dispersed and were therefore only occasionally noticed on *Lantana*. The adult grasshoppers have on a few occasions been noticed feeding on the flower-buds.

73. *Pyrgomorpha brachycera*, Kirby. This has been found occasionally on *Lantana* around Gudalur and in the Wynaad.

74. *Pyrgomorpha conica*, Oliv. This species was found feeding on *Lantana* leaves and flowers in very small numbers at Hoshiarpur and Dhariwal in the Punjab.

75. *Atractomorpha scabra*, Thurb. A few were observed feeding on *Lantana* at Kathgodam, U. P. Young ones were also noticed.

76. *Atractomorpha blanchardi*, Kirby. A few were noticed on *Lantana* at Dhariwal in the Punjab. Young ones were also observable.

Sub-family Eumastacinæ.

77. *Mastacides vaginalis*, Sauss (?). A green, short-horned, wingless grasshopper which has the peculiar habit of resting on leaves with its hind legs

stuck out sidewise at right angles to the body. It has been found in small numbers in the Wynaad, Coorg and the Anamalais attacking the flowers and leaves of *Lantana*. It also feeds on some other plants in Coorg.

Sub-family Catantopinæ.

78. *An undescribed grasshopper* (probably near *Wacata*). This species was noticed in fairly good numbers at Sidapur (Coorg) in March-April 1917. Young ones were found in plenty in March and by May they had become full-grown. The young hoppers are yellow-brown in colour while the adults assume a beautiful bright metallic blue. The mature grasshoppers have long filiform antennæ, and relatively large eyes : the tegmina and the wings are both absent and the prosternal tubercle is very feebly developed. They are very alert and active and feed chiefly on the leaves, eating numerous holes into them, and sometimes also on the flowers. This species was found feeding on other shrubs also in Coorg ; it has also been noticed to be present in the Wynaad, in the Anamalais, at Sagar in Mysore and at Castlerock.

79. *Coptacra* sp. ? Found on *Lantana* at Gauhati, Assam, in July 1918.

80. *Catantops splendens*, Thunb. Found on *Lantana* at Gauhati, Assam, July 1918.

Sub-family Tryxalinæ.

81. *Aiolopus tamulus*, F. Found on *Lantana* at Dehra Dun.

Family Phasgonuridæ.

82. *Letana atomifera*, Brunn. A long-horned grasshopper of green or greenish yellow colour. The tegmina are elongate and leaf-like, the ovipositer short and curved. It has several times been noticed feeding on the leaves and the flowers of *Lantana*. A grasshopper, which was kept alive in a pillbox and fed on *Lantana* leaves, laid eggs in the tissues of one of them. It has been collected on *Lantana* at Coimbatore, Bangalore, Ramandrug (Bellary District) Dehra Dun and Kathgodam (U. P.), Nagpur (C. P.).

83. *Ducetia thymifolia*, Fb. (?). Found on *Lantana* at Gauhati.

84. *A small Phasgonurid* (*Anisoptera* ?). An immature specimen was found at Yercaud (Shevaroys), biting into the corollas of flowers at their base, presumably in order to feed on the pollen-sacs but possibly also to attack the young Thrips inside. One specimen was kept in a pillbox and lived therein for nearly two months invariably biting into the base of the corollas of the flower-heads provided as food.

Two other species of Phasgonurids were collected on *Lantana* but are unimportant.

Family Phasmidæ.

A few Phasmids were observed in different places resting on *Lantana* leaves, but it is doubtful if they feed on *Lantana*.

ISOPTERA.

Family Termitidæ.

85. *Termes* (*Macrotermes*) *annandalei*, Silv. This species was noticed attacking the stems of *Lantana* plants in a hedge found in the garden of the Superintendent of the Northern Shan States, at Lashio. The plants were fairly old and some of the attacked bushes were found drying up.

86. *Microcerotermes heimi*, Wasm. This termite was found attacking the stems of old *Lantana* bushes found on the plateau at Ramandrug (Bellary District). Only stray plants were attacked but the affected plants did not show any obvious signs of damage.

RHYNCHOTA.

Family Pentatomidæ.

87. *Plautia fimbriata*, Fabr. This bug has been noted on *Lantana* in a great many places in India and Burma ; Coorg, the Wynaad, Coimbatore, Nilgiris, the Anamalais, Bangalore, Burma (Rangoon, Pyinmana), Gurdaspur (Punjab). The eggs are laid in small clusters on the leaves and the young ones that hatch out migrate to the fruit-bunches. The adult bugs also attack the fruits. Though I could not ascertain how far the bugs, whether young or mature, actually affect the germinating power of the fruits, my observations of *Lantana* bushes infested by this bug lead me to conclude that it is not effective to any appeciable degree.

Mr. H. N. Ridley in his article on " Endemism and the Mutation Theory " (*Annals of Botany*, Vol. XXX, No. CXX, October 1916, pp. 552-553) makes the following remarks :—" When I first arrived in Singapore in 1888, this shrub (*Lantana mixta*) was very abundant all over the waste-ground in Singapore ; on my last visit there it had become comparatively scarce — one had to look about the country for it. I found a plant in the edge of the wood by the roadside, and on examining it found that every one of the young fruits on the whole bush was perforated by a small green Bug (*Plautia fimbriata*) and that all those fruits which had been sucked by the bug withered up and never came to maturity." As these observations were not confirmed by our experience in India, the question was referred by the Imperial Entomologist to

Dr. Hanitsch, Curator of the Raffles Museum, Singapore, who did not support Mr. Ridley's views. He remarked in his letter :- "I cannot say that during the 22 years I have been here I have found the slightest decrease of *Lantana*, except of course, so far as there is nowadays so much more and in Singapore, the Straits and F. M. S. under cultivation than formerly. The hedges in the Museum compound, in my private garden, all along the roads in the suburbs of Singapore are, as far as I can see, as full as ever of this plant."

This bug appears to have a very wide distribution in the Tropics, having been recorded from Ceylon, Burma, Tenasserim, Malay Peninsula and Archipelago, China, Japan and Madagascar.

88. *Plautia viridicollis*, Westwood. This bug very closely resembles *P. fimbriata* and is distinguished from it by its smaller size, the punctures on the pronotum and the scutellum being coarser, the apex of the scutellum being broadly greyish and the dorsal surface of the abdomen being violaceous instead of red.

It occurs in smaller numbers on *Lantana* in company with *P. fimbriata* and is much less common. It has been recorded by me from Mettupalayam, Coimbatore, Nilgiris, Wynaad (Manantoddy).

Recorded in the *Fauna of British India* from Java and Ceylon.

89. *Halyomorpha picus*, Fabr. A dark-brown bug of moderate size, found on *Lantana* bushes in a great many places in India. The eggs are usually laid on leaves. In one instance an egg-cluster, found laid on the undersurface of a *Lantana* leaf at Sidapur, contained 25 eggs, which were more or less spherical with both the poles considerably flattened; opaque-white in colour, about 1·25 mm. in diameter, and with the egg-cover surrounded by a circlet of tiny knobs. The eggs, which were collected on the 27th March, 1917, hatched on the 30th March, 1917, into small black and yellow nymphs. Two of the nymphs reared separately gradually passed through 5 moults and became adults on the 5th and the 8th May, 1917, respectively.

The half-grown nymphs are flattened and are very dark in colour and can be easily recognized. Both the nymphs and the adults are found feeding on fruits, but as they generally seem to feed chiefly on the pulp of the mature fruits, they are of very little use as a check on *Lantana*.

According to Distant this species has a wide distribution outside India, being recorded from Ceylon, China, Japan and Malaya.

On *Lantana* I have noted it from the following places :- Coimbatore, Coorg, Nilgiris, Wynaad, Ramandrug (Bellary), Dharwar, Burma, Haldwani (U. P.).

90. *Halys dentatus*, Fabr. Found on a few occasions on *Lantana* fruits, Bangalore.

91. *Tolumnia latipes*, Dall. ? A striking darkish bug with bright yellow spots on the scutellum : found in small numbers on *Lantana* fruits at Sidapur (Coorg), Wynaad, Bangalore and Gauhati (Assam).

92. *Dolycoris indicus*, Stâl. Found on *Lantana* fruits, Shillong, Assam.

93. *Antestia cruciata*, Fabr. Found on *Lantana* fruits in small numbers chiefly in the Hills, Nilgiris (Coonoor and Katteri), Shevaroys (Yercaud) and also at Coimbatore.

94. *Nezara viridula*, Linn. Sometimes found feeding on *Lantana* fruits : noted at Bangalore, Sidapur, Pollibetta in Coorg, in Burma, at Kathgodam and Dehra Dun in U. P.

95. *Catacanthus incarnatus*, Dru. Found once at Coimbatore on *Lantana* : Mr. P. V. Isaac coll.

96. *Cantao ocellatus*, Thurb. Found once at Sidapur on *Lantana*.

97. *Chrysocoris stollii*, Wolff. Found on *Lantana* at Pusa (A. G. R. coll.) and also at Gauhati in Assam.

98. *Placosternum taurus*, Fabr. Occasionally on *Lantana*, Bangalore.

99. *Brachycerocoris camelus*, Costa. A small bug of rather bizarre appearance. Found breeding in small numbers on *Lantana* berries at Malleswaram, Bangalore, July 1917.

100. ? *Hoplistodera* sp. Found in small numbers on *Lantana*, Shillong.

Family Coreidæ.

101. *Clavigralla gibbosa*, Spin. } Noted on *Lantana* flowers, Coorg and
102. *Clavigralla horrens*, Dohrn. } Coimbatore.

103. *Acanthocoris scabrator*, Fabr. Once noted on *Lantana* in Coorg (Sidapur).

104. *Homœocerus striicornis*, Scott. Noted on *Lantana* ; Bangalore, Gauhati, and Shillong.

105. *Homœocerus inornatus*, Stâl. Collected on *Lantana* leaf, Cawnpur, December 1918.

106. *Riptortus linearis*, Fabr. } Both found in small numbers on
107. *Riptortus pedestris*, Fabr. } *Lantana* flowers, Coorg.

108. *Cletomorpha raja*, Dist. Found on numerous occasions on *Lantana* flowers in Coorg : it is found in fairly good numbers. Once noted also at Dharwar.

109. *Cletus rubidiventris*, Dist. In small numbers on flowers ; Coimbatore, Sidapur, and Ramandrug.

110. *Corizus rubicundus*, Sign. This small bug has been taken on several occasions on *Lantana* flowers, on which they usually cluster in groups of 3 to 10 : noted chiefly in Coorg, but also collected at Pyinmana in Burma and Dehra Dun and Bangalore.

Family Lygæidæ.

112. *Melanotelus* sp. In small numbers on flowers ; Sidapur (Coorg).

113. *Aphanus* sp. On flowers ; Pollibetta (Coorg).

114. *Lygæus hospes*, Fabr. On *Lantana*, Dinanagar, Punjab.

115. *Lygæus* sp. On *Lantana*, Sidapur.

116. *Geocoris tricolor*, Fabr. On *Lantana* flowers, Coimbatore, Gurdaspur and Pyinmana.

Family Pyrrhocoridæ.

117. *Physopelta gutta*, Burm. On *Lantana*, Coorg.

118. *Dysdercus cingulatus*, Fabr. Found in small numbers on flowers and fruits ; Sidapur, Shillong, Gauhati, Kyidaunggan, Pyinmana, Dehra Dun, Sarna.

Family Phymatidæ.

119. *Amblythyreus* sp. Found on *Lantana* leaves, Anisakan, Burma (3,000 ft.).

Family Capsidæ.

120. *Megacœlum stramineum*, Wlk. Noted on one occasion on *Lantana* flowers, Kallar (1,200 ft.), Nilgiris.

121. *Megacœlum* sp. Laying eggs in axis of *Lantana* flowers : Runnymede (5,000 ft.) and Katteri (5,500 ft.), Nilgiris.

122. ? *Pœciloscytus longicornis*. Found occasionally on *Lantana* flowers : Sidapur, Coonoor.

123. *Dercœocoris* sp. ? On *Lantana* flowers : Coimbatore, Dehra Dun.

124. ? *Lygus* sp. On *Lantana* flowers, Coimbatore.

125. ? *Campylomma* sp. A small green Capsid found in moderate numbers on *Lantana* flower-heads in a great many places in India : Dehra Dun, Sarna, Hoshiarpur, Kathgodam, Cawnpur, Darnaoganj, Nagpur, Kallar (Nilgiris).

The bug lays eggs in the tissues of the flower axis and the young ones that hatch out suck the juices of the flower-heads. When found in sufficiently good numbers, the flowers of attacked flower-heads drop off.

126. *Helopeltis antonii* ? Noted on one occasion on *Lantana* at Pyinmana in Burma, where it also attacks *Nim* trees as in India.

Family Anthocoridæ.

127. *Triphleps* sp. This small bug has been noticed among *Lantana* flowers in a great many places in India, running in and out of the corollary tubes. It is presumably a predator probably feeding on the Thrips that infest the flowers.

Family Fulgoridæ.

128. *Ricania marginalis*, Wlk. Found in small numbers on the branches at Sidapur, Coorg.

129. *Ricania coorgensis*, Dist. Found on *Lantana* in small numbers in Coorg.

130. *Ricania bicolorata*, Dist. Between January and March *Lantana* bushes at elevations of 2,000 to 3,500 ft. near Hillgrove on the Nilgiris were found infested with large numbers of the young ones of this species. The nymphs possess long and conspicuous white mealy appendages and branches covered by these bugs looked from a distance as if they were attacked by mealy bugs. In spite of the large numbers present, *Lantana* branches did not evince any signs of serious injury. These bugs were also noted on various other low-growing shrubs.

131. *Eurybrachys* sp. Occasionally found on *Lantana* in S. India.

Family Membracidæ.

132. *Leptocentrus taurus* ? Occasionally on *Lantana*, Dhariwal, Punjab.

Family Cercopidæ.

133. *Ptyelus præfractus*, Dist. Found breeding on *Lantana* in the Wynaad and Coorg in November 1917. The young ones are enveloped in spittle and attack the twigs. Found, however, only in small numbers.

134. *Phymatostetha deschampsi*, Leth. Found on *Lantana* in the Wynaad.

Family Jassidæ.

135.....a Jassid (not identified). A slender green and brown species : found in small numbers on *Lantana* at Dehra Dun.

136. *Idiocerus atkinsoni*, Leth. Occasionally found on *Lantana* : Fatehgarh, Dehra Dun, etc.

137. *Idiocerus clypealis*, Leth. Found in small numbers on twigs : Hoshiarpur, Fatehgarh, etc.

138. *Tettigoniella ferruginea*, Fabr. Found in small numbers on *Lantana* bushes in the Western Ghats region, Coorg, Wynaad, etc.

Various other bugs including Jassids, Cercopids and Fulgorids have been collected on *Lantana*, but they have not been identified and are of very little importance individually.

Family Aphididæ.

139.....(Identity not known). *Aphis* is sometimes found infesting whole bushes, causing a diminution of seeding, as round about Coimbatore. It, however, appears only after the Rains.

Family Aleyrodidæ.

140. *Aleyrodes* sp. (probably *A. ricini* ?). An overgrown hedge of the pink variety of *Lantana* was noticed along the side of the railway embankment to the left of the road leading to Sitabaldi. The plants in this hedge were infested with large numbers of whiteflies. All the older leaves were more or less thickly covered with the scales on the under surface, while on the tender leaves and shoots large numbers of the milk-white adult flies were found clustering together. Innumerable eggs were noticed to have been laid on the tender leaves. In spite of the large numbers of the Aleyrodid, the plants were not observed to show any appreciable signs of damage. In a public garden at Cawnpur, similar whiteflies were noted on *Lantana*, but eggs and larvæ were not observed on it though certain low shrubs near by, probably *Adhatoda vasica*, were thickly covered both by the larvæ and the adults.

A small number of the whiteflies were always noticeable among the flowers in a great many places in North India, having been collected at Gurdaspur, Pathankote, Hoshiarpur, Dehra Dun, Kathgodam, Lucknow, Cawnpur, and Nagpur, but in none of these places except the last was the insect found actually attacking the *Lantana* plant.

A small yellow parasite was reared out from the larvæ.

Family Coccidæ.

141. *Pseudococcus* sp. This species was commonly found on *Lantana*, affecting the leaves, fruits and the flowers, throughout South India, but was present in small numbers.

142. *Pseudococcus* sp. (*virgatus* ?). This species differed from the preceding both in form and habits. It was noted on *Lantana* in Bangalore in May 1917. It was very gregarious and occurred in masses both under the leaves and on the twigs. The quantity of the waxy secretion was very much greater. It was noted only in a small number of bushes in a hedge opposite the Central College, where, however, it occurred in profusion. The

affected bushes appeared decidedly unhealthy and the formation of the flowers was greatly impeded. When examined again in June 1917, the mealy bug had almost disappeared, having been apparently checked by ladybirds and *Chrysopa*.

Large numbers were noticeable on the bushes of the same hedge in April 1919, and the attacked leaves had become crumpled up.

143. *Pseudococcus* sp. (Kathgodam). At Kathgodam some of the branches of several *Lantana* bushes were found harbouring probably a third species of mealy bug. The bugs were found clustering on the twigs and the young ones were noted both on the upper and the lower surfaces of the leaves and among the flowers and the fruits. It, however, did not occur in sufficiently large quantities to constitute a check on *Lantana*. (Plate XXXVI, fig. L.)

144. *Pulvinaria* sp. (Bangalore). In addition to the *Pseudococcus* sp., mentioned above, many of the bushes at Bangalore were also infested with scales, probably a species of *Pulvinaria*. The mature female individuals bore mealy ovisacs, like *Pulvinaria psidii*. They occurred chiefly on the twigs, but sometimes also low down on the stems and on the leaves. These were also attacked by ladybirds and a Chalcidid parasite. Observed in abundance in May 1917, it had almost disappeared in June 1917 at Bangalore. In July 1917, the same scale was observed on *Lantana* plants in small numbers about the 16th mile from Mysore along the Mysore–Hunsur Road.

145. *Icerya* sp. Small numbers of an *Icerya* were noted on *Lantana* at Manantoddy, Wynaad. It was however evident that they had strayed on to *Lantana* from a species of *Ficus* near by, on which they were found in abundance.

146. *Orthezia insignis*, Doug. The *Lantana* bug: the *Mani* blight of Hawaii.

I found this bug attacking stray *Lantana* plants on Barwood Estate, in the Ouchterlony Valley of the Nilgiri District. Introduced unwittingly along with garden plants either from Ceylon or from the West Indies, the first indication of the presence of this bug was, according to Mr. J. F. Nicholls, the Manager of the Estate, the absolute destruction in 1915 of a fine hedge of white *Lantana* planted around the Estate Bungalow. Specimens of the scales were forwarded by him for examination to Mr. Anstead, who transferred them to Dr. L. C. Coleman, Director of Agriculture, Mysore State. On receipt of information regarding the injurious nature of the insect, the infested *Lantana* hedge was cut out and destroyed by burning. The infested garden plants were also reported to have been similarly treated. At the time of my visit to Barwood on the 18th September, 1917, I was able to find, with the help of the

PLATE XXX

Estate writer, several stray *Lantana* plants round about the bungalow badly infested with *Orthezia*. The scale was also noted on the following weeds near by :—*Bidens pilosa, Ageratum conyzoides, Sida rhombifolia, Urena lobata* and one or two grasses, but only in small numbers. *Lantana* was evidently preferred. In one instance a dead bush of *Lantana*, with manifest traces of the scales on the twigs, was found around the base of a healthy *Citrus* tree which did not appear to have been attacked. Various garden plants including *Crotons* appeared to have suffered. The scale had appeared on tea in small numbers but did not do much harm.

The Manager of the Estate was informed of the recurrence of the scale on the Estate and was advised to have the whole patch thoroughly destroyed.

An outbreak of this scale-insect was reported in January-March 1919, to the Government Entomologist's office, Coimbatore, from the Audatode Estate, Perindotty P. O., near Vayitiri, Wynaad. The Manager, Mr. H. B. Winterbotham, reported : " Last year I cut down and burnt all the shrubs on which the scales appeared and saw nothing more of them for some months. For the last 3 or 4 months they have reappeared in great numbers and I have a great fear that they should get on to my tea."

The life-history of this bug appears to have been studied by Mr. Kunhi Kannan, the Senior Assistant Entomologist, Bangalore, and according to him *Lantana* plants infected by young scales in 1915 were completely killed by the close of 1917.

The circular issued by Mr. E. E. Green in 1899 about this scale-insect (*Trop. Agriculturist*, April 1899, p. 673) gives exhaustive information regarding the appearance of this insect in Ceylon. According to him this scale was first noticed in Ceylon in 1893 on garden plants in the Botanical Garden, Peradeniya, presumably imported from Kew Gardens, London. In 1894 it was first noticed to have appeared on *Lantana*. From Peradeniya it spread all round, into Kandy, Rangalla, Gampola, Nawalapitiya and Badulla. [It was common on *Lantana* at Diyatalawa in 1908—T. B. F.] According to Mr. Green, there may be as many as five generations during a year. Males appear to be produced only at long intervals and it is even doubtful if a generation of males is produced at least once a year. The original home of the insect probably lies somewhere about the West Indies, Mexico or British Guiana. The following foodplants are recorded by him :—

Acanthaceæ. Crossandra, Justicia, Thunbergia, Meyenia, Strobilanthes.

Rubiaceæ. Cinchona, Coffee, *Gardenia, Hamelia, Ixora* and many other common weeds.

Verbenaceæ. Verbena citriodora, Lantana, Stachytarpheta, Duranta.

Compositæ. *Tithonia* (wild sunflower), *Chrysanthemum*, *Achillea*, *Vernonia*, *Ageratum* (goat weed) and many common weeds.

Solanaceæ. *Habrothamnus*, *Capsicum*, "Tomato."

Labiatæ. *Coleus*, *Salvia*.

Rutaceæ. Orange and various kinds of *Citrus*.

Leguminosæ. *Clitorea*.

Caprifoliaceæ. *Lonicera* (Honeysuckle).

Bignoniaceæ. *Tecoma*.

Rosaceæ. Strawberry.

Amaranthaceæ. *Iresine*.

Ternstromiaceæ. Tea.

Convolvulaceæ. *Ipomœa*.

Lythraceæ. *Cuphea*.

The Imperial Entomologist has personal knowledge of its occurrence in Ceylon (*Proceedings of the Second Ent. Meeting, Pusa*, 1917). "The affected shoots die back and become black as if scorched, but the scale seems to occur only in patches and can hardly be looked on as an effective check."

In Hawaii, the ranchmen appear to have introduced it on *Lantana*, independent of the efforts of Mr. Koebele, who strongly condemned their action. It, however, was reported to be effective in killing *Lantana* in Hawaii.

According to Mrs. Fernald's *Catalogue of the Coccidæ of the World*, the habitat of this species includes England, South Africa, Mauritius, Ceylon, China, Brazil, Brit. Guiana, Trinidad, Jamaica, Mexico and the United States.

On account of the omnivorous nature of this scale it need not be stated that it is not an insect which can in any way be encouraged.

THYSANOPTERA

Suborder Terebrantia.

147.....(not identified). This small Thrips is found abundantly in *Lantana* flowers throughout Southern India ; a similar and probably identical form was also noticed throughout Northern India and Burma.

At Sidapur and Bangalore, and in South India generally, two distinct forms were noted among the Thrips frequenting the flowers ; one was very dark blackish-brown, and the other very light coloured, a very pale yellow and much smaller. Examination under the microscope of specimens collected at Sidapur showed that the dark forms were invariably of the female sex, while the light ones were all males. Moreover, I have personally observed on more

than one occasion at Bangalore and Sidapur the light ones actively courting the darker forms and I have therefore no doubt that at least in South India there is a pronounced sexual dimorphism in this species. On the other hand, examination of specimens collected at Gurdaspur, Kathgodam and Pusa has revealed the presence of the light-coloured forms, but these were invariably of the female sex, the saw-like ovipositor being plainly noticeable. I do not know whether the North Indian form is a different species or whether the absence of the male individuals was only attributable to the effect of the season, all these specimens having been collected in the cold weather.

The eggs are laid in the tissues of the corolla and shine through the thin tube when held up against the light. They feed on the pollen and the nectar and also attack the tissues of the corolla, on which pale blotches are distinctly noticeable at the parts damaged. When Thrips are abundant the flowers look as if bleached all round the centres and present a distinctly woe-begone appearance. In bad cases of damage, fruits may not set, but usually the presence of the Thrips is helpful for the plant in the matter of fertilization, as was proved by the bagging experiments.

Suborder Tubulifera.

148.....(not identified). Another Thrips, a jet-black one with an elongate body and a tubular terminal segment, was also noted on *Lantana* flowers in most places in India. It was present in much smaller numbers than the above-mentioned one. The eggs are laid free among the hairs on the tender buds. Generally they are not harmful, but a few instances were noted in Coorg where, due to the presence of this Thrips in abundance, the flower-clusters had withered up.

FUNGUS DISEASES.

(1) About 10 miles from Tumkur, Mysore State, a few *Lantana* plants were found dying along the roadside. On examination it was found to be due to the action of a fungus attacking the roots and the base of the stem. (Plate XXXVI, fig. 2.) Specimens of the diseased parts were taken to Mr. Ch. Noronha, who was then Mycological Assistant at the Bangalore Agricultural Laboratory, and were reported by him to have been attacked by one of the Polyporaceæ.

(2) Another distinct type of fungus attack was noticeable all over Coorg and the Wynaad, around Gudalur, around Sagar in Mysore, Malnad, and in parts of the Anamalai Hills. Leaves of individual branches were noted turning reddish and later on drying up. On examination, the cause was found to be due to the occurrence of a definite bark disease of the branches. The diseased

patches were clearly defined and varied in size and usually covered the whole girth of the twig or stem. They were brown in colour and were often covered on the surface by a network of fungus strands. In later stages small reddish papillæ pushed their way out through cracks in the bark. The bark both above and below the diseased patch was quite healthy but along the edges of the distal end of the diseased part a callus was developed, forming a pronounced thickening from which adventitious roots were given off.

This disease was noted in abundance in Coorg and the Wynaad, especially at Virajapet, Pandalur and Vayitiri, and in some cases whole bushes were affected, most of the branches showing evidences of attack. This disease, however, appears to be restricted to very rainy areas and is very much in evidence only at the close of the Rains.

Dr. F. J. F. Shaw, Second Imperial Mycologist, reported on 8th October, 1917, as follows on specimens forwarded in September 1917 from Gudalur :— "The specimens [are infected with a basidiomycetous fungus belonging to either the genus *Corticium* or *Hyporhum*. Fungi of these genera are the perfect spore-producing stage of the sclerotial genus *Rhizoctonia*, and attack a number of important crops, *e.g.*, groundnut."

A detailed study of this peculiar disease would in my opinion be of much interest.

VEGETABLE PARASITES.

The Dodder (probably *Cuscuta reflexa*). *Lantana* was observed to be subject to the attack of a dodder at the following places :—Pyinmana (Burma), Dehra Dun, Kathgodam and Cawnpur.

It was, however, at Kathgodam and Haldwani that large quantities of this dodder were noticed on *Lantana*. At Haldwani whole hedges of *Lantana* were covered by the tangled masses of this plant and the attacked branches were distinctly unhealthy and did not put forth flowers or fresh shoots (Plate XXXVII). This plant parasite would however appear to flourish only in very rainy areas.

8. CONCLUSIONS.

As may be noted from the preceding list, a fairly large number of insects has been found feeding on *Lantana*, especially in South India, but few of these are really important. The most efficient of all is undoubtedly the Plume-moth, *Platyptilia pusillidactyla*. It is found throughout India except perhaps in the Punjab, and has an almost world-wide distribution. In India it also breeds in *Lantana indica* and *Lippia geminata*. The multiplication of *Lantana* seeds is checked to a considerable extent but, being itself kept in check by

Dodder on *Lantana* hedge at Haldwani, U. P., December 1918.

parasites, the insect is not very efficient. The various microlepidopterous caterpillars, such as *Lobesia* and *Cacoecia*, are not found in sufficient numbers to prove efficient checks. The Lymantriads, such as *Euproctis* spp. and *Olene mendosa*, would be efficient if they occurred in sufficient numbers, but as they also attack cultivated plants, they cannot be encouraged. The Noctuid caterpillar, *Hypena* sp., as well as the Arctiads are chiefly leaf-feeders and are not so useful as those that feed only on the flowers and thus directly control seed-formation. The gall-fly, *Asphondylia* sp., even when it occurs in abundance, is of low efficiency and as it is very probably identical with *Asphondylia* sesami*, which is fairly serious on *til* at Coimbatore and Nagpur, ought not to be introduced into new districts. Of the bugs, *Plautia*, *Nezara*, etc., are found feeding on fruits, while others attack the flowers, *e.g.*, the small green Capsid; but it is doubtful if the bugs, on the whole, are really efficient. The *Lantana* bug, *Orthezia insignis*, which has been unconsciously introduced into the Wynaad, is on the other hand, an efficient check on *Lantana*, as it is known to kill bushes outright, but owing to its well-known polyphagous nature it is an insect whose presence ought not to be tolerated.

The nett result of the present inquiry appears unmistakably to indicate the absence at present of any indigenous insect capable of checking the spread of *Lantana* in India. However, at least in parts of India, some insects are sufficiently numerous to serve as auxiliaries, if an efficient insect of the nature of the *Lantana Agromyza* were to be introduced.

Failing the presence of an indigenous insect check on *Lantana*, the question of the importation of the seed-fly may perhaps be considered next. The following three aspects of the question appear to be important: (1) Is the introduction of the Agromyzid *necessary* ?, (2) is it likely to be *useful* ?, and (3) is it *safe* ?

The *Lantana* plant is an instance of a vegetable pest that has been introduced without its natural check and the most rational method would appear to be to restore the equilibrium of Nature, always assuming that the importation will not upset it in other directions in the new country. Mechanical eradication may by itself be sufficient to check *Lantana*, but usually the plant again regains its original dominance after a time, if it is not periodically kept down. Considering the extent of land over which *Lantana* has established itself, the cost of eradicating it over the whole area will be enormous, and there is therefore no doubt as to the superiority of this method over mechanical destruction. Again the seed-fly simply acts as a check on the spread of the

* It is quite distinct from *A. sesami*. [T. B. F.]

plant but does not destroy it, so that the measure will be able to satisfy the party that considers it a nuisance as well as the one that regards it as beneficial.

As to the usefulness of the introduction, we have to depend on the experience of countries where the measure has been tried. In Hawaii (*Trop. Agriculturist*, April 1904, p. 657) Dr. Perkins reported that out of the 8 Mexican insects which he liberated, "the success of the *Agromyza* was instant and phenomenal." Mr. D. T. Fullaway, Entomologist, Division of Entomology, Honolulu, wrote as follows in reply to an inquiry made by the Imperial Entomologist: "My own personal experience only goes back ten years, but I think I am justified in saying that the spread of *Lantana* has been distinctly checked, if not altogether stopped, and that was the result desired. The principal agents in this work are the Agromyzid fly and the moth borer [probably *Platyptilia*] which works in the flower-heads. As far as I know, these insects have confined themselves entirely to *Lantana*."

Successful results are reported from Noumea (New Caledonia) and Fiji where the seed-fly alone had been introduced. It is reported that in Fiji nearly 95 per cent of the fruits were found infested, and there appears to be little doubt that an introduction of the seed-fly into India will be as efficient as in other places.

Mr. W. W. Froggatt, Entomologist, New South Wales, however, sounded a warning note in commenting on the introduction of the fly into Fiji. "Though the *Lantana* berry parasite has been in Hawaii since 1906, there is still plenty of *Lantana* on the waste areas, and it is not claimed by its advocates that it kills *Lantana* at present occupying the land. Residents of the North coast have at various times requested that the fly should be introduced, but it is considered that the conditions in Australia are so different to those of an island where the main crop may be sugarcane or coconuts, that no berry- or seed-eating fly should be brought in. A fly that attacks *Lantana* berries might very possibly attack many things commonly grown in Australia."

It is to be admitted that it is always a dangerous measure to introduce foreign insects, without first knowing everything about them. Even if an imported insect be innocuous in its original home, it is quite possible that in the country of its adoption, it may, owing to the effect of new environments, suddenly change its habits and develop into an injurious insect.

As far as the *Agromyza* is concerned, the evidence seems to point out that it is a safe insect to introduce. The views of Mr. H. Tryon, Government Entomologist, Queensland, on this point were published in the *Queensland Agricultural Journal*, April 1917, p. 183: "The introduction of the insect would

present no interference with the use of *Lantana*, by those who desired to do so, as a cover-crop or as a means of honey production. The habits of the fly, so far as they relate to forms of vegetation other than *Lantana*, had also been under close observation for years. It was, therefore, possible to affirm that neither in its native home, Mexico, nor in any of the countries into which it has been introduced, has it ever associated itself injuriously with any plant other than *Lantana*. There was no ground for any suggestion that the insect was likely to change its habits, the experience being that in the absence of *Lantana* no propagation took place and that eventually it died."

The seed-fly has been existent in Hawaii since 1902 and has therefore been long enough there to have definitely declared tendencies, if any, of turning its attention to other plants. The cultivated plants of Hawaii and India are very likely to be identical, both being parts of the Tropics, and as far as the crops are concerned the insect may therefore be considered safe. The general flora of the two countries is, however, likely to be very different, as they belong to different regions botanically. Many of the important Verbenaceous plants of India, for example, teak, are absent from Hawaii and unless actual experiments are made, it is impossible to say whether these Indian Verbenaceous plants will be free from its attacks. As far as teak is concerned, I am of opinion that the fruits, which are different both in size and structure from those of *Lantana*, are not likely to be attacked. The only plant which is likely to be infested, in India, appears to me to be *Lantana indica*, happily a plant without any economic significance.

Moreover, unlike scale-insects which are able to adapt themselves to almost any plant, the seed-fly is a type of an insect with specialized habits. The Agromyzid, that breeds in the seeds of *Cajanus indicus* in India, has not been reared from any other plant in India, and I should think that it is as unlikely that the *Lantana* Agromyza would turn its attention to any other plant except perhaps *L. indica*. It is, however, very important that as close a study as possible of the insect in relation to its behaviour with regard to the Verbenaceous plants in Hawaii* and to those of India under control in cages be made, before the actual liberation is contemplated.

The Agromyzid appears to be subject to the attacks of a parasite both in Hawaii and Fiji and since the efficiency of the fly is likely to be greatly reduced if the parasite is also brought in, measures might be adopted to bring about the elimination of the parasite.

* It is however unfortunately the case that practically no Verbenaceous plants other than *Lantana* occur in Hawaii. [F. B. F.]

Moreover, an attempt appears to have already been made, a few years ago, by Dr. L. C. Coleman of Bangalore, to import the maggots and pupæ of the fly under cold storage, from Hawaii, but it was not successful as the flies died during transit. It must of course be always kept in mind that our aim in seeking to introduce this fly is to check the spread of the plant by reducing the production of sound seeds and in case this object is accomplished, *Lantana* would settle down into the rank of many a harmless weed whose presence we do not very much care about.

9. OTHER PESTILENTIAL WEEDS.

Lantana is not by any means a unique instance in India of an introduced plant that has assumed the status of a troublesome weed. The following are notes of some of the observations, made in the course of the present inquiry regarding certain plants which I found running wild under certain peculiar conditions.

Prickly Pear is a familiar example of an introduced American plant which has proved a troublesome pest like *Lantana* but capable of thriving only under very different conditions. Whereas *Lantana* appropriates the moister areas, Prickly Pear flourishes best in dry and almost desert conditions. It appears to have been imported into India more than a century and a half ago in connection with the cultivation of the cochineal insect for the sake of its much prized dye. In most cases, however, the wrong species of the Cactus appears to have been imported, such as *Opuntia Dillenii* and *Opuntia nigricans*, on which the true cochineal insect, *Dactylopius coccus*, "grana fina," did not thrive and again in a great many cases, the wrong species of the cochineal, the wild cochineal insect, "grana sylvestre," *Dactylopius indicus*, Green, which increased to such an extent on the real Cochineal cacti, *Opuntia monacantha* and *Nopalea cochinelifera*, as to lead almost to their extermination in India. Though the cochineal industry failed, the Cacti got established and have assumed pest conditions in waste-lands around villages in the drier parts of India.

Then there is the Sensitive plant, *Mimosa pudica*, originally a native of Brazil, which has become established in many of the moister areas of India and Burma. It is a pest of a bad type in the lowlying lands and the pasture grounds in Coorg. It covers up and suppresses the grasses and is felt to be a nuisance, as its prickles produce sores of a septic nature on the bare feet of agricultural labourers. It is chiefly spread by goats which feed on the pods and broadcast the seeds along with their droppings. In fact, I have heard

many people in Coorg and Malnad stating that they considered *Lantana* the less serious of the two evils.

There is next the remarkable case of the Water Hyacinth, *Eichhornia crassipes*, "*Beda-ben*" (Burmese), which has spread with phenomenal rapidity throughout India and Burma within about a decade of its introduction. Originally a native of Tropical America, it was introduced as a rare plant in Botanical Gardens, and very soon travelled from tank to tank owing to the possession of fascinatingly beautiful flowers. It, however, did not take a long time for people to discover the real nature of the plant, but by then it had already begun to infest all fresh water ponds, pools and water-channels.

There is another plant, the potentialities of which seem yet to be but little realized, that is spreading with alarming rapidity in the moist areas of Burma, Assam and Bengal. It is *Eupatorium odoratum*, Linn., a weed belonging to the order Compositæ, the place of origin of which according to the *Index Kewensis* is Tropical America. Hooker remarks in his *Flora of British India* "that it is a West Indian plant cultivated but rarely in India," and Prain in his *Bengal Plants* notes that "it is cultivated sparingly in Central and East Bengal, a coarse herb." In Burma it is known as "*Bi-zat*" or "*Taw-bizat*." In Assam, it appears to be known by the following interesting and expressive vernacular names, for which I am indebted to Rai Bahadur Upendranath Kanjilal, Retired Extra Deputy Conservator of Forests—

Tongal-lati.—(Assamese; lit., split bamboo creeper.)

Sam khabli.—(Kachari; lit., Kabul Plant; so named as it is believed to have been spread by the Kabuli coolies employed when constructing the Assam-Bengal Railway.)

Kombat-nong-rim.—(Khasi; lit., plant of old abandoned villages.)

Kal-bun.—(Mikir; lit., new weed.)

Rél-Hlow.—(Kuki, Lushai Hills; lit., the railway herb.)

San-khauri.—(Sylhet; lit., eater of thatching grass.)

Burma-chik.—(Tipperah; lit., Burma plant.)

It was Col. G. H. Evans, Superintendent, Civil Veterinary Department of Burma, who first drew my attention to the presence of this plant in Lower Burma, and gave the information that, of late years, it was making extensive inroads into the jungle, covering up wide areas. In his opinion, it was far worse than *Lantana*, which was after all not important so far as Lower Burma was concerned. He also informed me that it was popularly known in Rangoon as the "Curse of Ceylon," being believed to have been imported from that Island. At Moulmein, I was informed by the Deputy Commissioner that it was locally known as "Camphor grass" and also as the "Siam weed."

According to him it is believed to have been brought in by a cyclone from over the Siamese borders, a not improbable view since the seeds are wind-borne and very light.

On the other hand, Mr. C. G. Rogers, Chief Conservator of Forests, Maymyo, was of the opinion that it was an indigenous species, probably found all over Burma, but I have very little doubt that it is an imported plant which has, very much like *Lantana*, got out of control.

As to its distribution in Burma, Mr. Rogers furnished me with the following note :—" It is spreading rapidly from Moulmein and Rangoon up both Railway lines (main line to Mandalay and line to Prome). It is common in Kodan-chaung in the Upper Chindwin District and I have seen it in the Reserved Forests in the Pyinmana District. It grows very prolificly in the Tenasserim Civil Division, where it is reported to be doing considerable damage to teak plantations in the Thangyin Division. It is interfering with a teak plantation near Kodugwe in the Tharrawaddy Forest Division made in 1914."

I found this plant " *Bi-zat* " in great abundance chiefly in Lower Burma, large masses being noticeable around Moulmein, Pegu, Pyinmana, and Rangoon. It was, however, along the railway line between Thaton and Pegu and particularly between Hninpale and Kyaikto, that this plant showed an extravagant exuberance of growth, unequalled even by *Lantana*, extraordinarily dense thickets covering extensive areas of jungle-land being noticeable.

I did not notice " *Bi-zat* " in the dry region of Central Burma (Thazi, Meiktila and Mandalay) nor anywhere in the Northern Shan States. In Upper Burma I found this plant growing wild only in two situations along the line from Mandalay to Myitkyina, in a private garden near the Kotaungbo Railway Station, and secondly on either side of the railway line between Nankan and Bouchaung, where it passes through very hilly country along the side of a great ravine. The plants were found along the sides of the track and must have been unwittingly introduced, as in Assam, by gangs of coolies working at the construction or repairs of the bridges near by.

In the Southern Shan States I found a few bushes of " *Bi-zat* " growing near the platform of the first reversing station, between Lebyin (1,500 ft.) and Hmodon (3,900 ft.) on the hill section of the Thazi-Kalaw line. It may have been introduced along with garden seeds imported by the station staff. A few plants were also found a short distance further up the line.

From information collected from the Forest Department in Assam, this plant is now to be found spread throughout the Province. It is noticeable in

extraordinary abundance on the sides of the hills around Gauhati, and also all along the Shillong-Gauhati Road up to a height of about 3,000 ft. The Garo and the Lushai Hills are reported to be covered up by masses of this weed, while in the Surma and the Brahmaputra Valleys it is reported to have followed in the wake of the construction of the main line of the Assam-Bengal Railway running from Chittagong to Dibrugarh. In Bengal I have observed it growing in abundance on either side of the main line of the E. I. Railway from about the 30th mile stone to very near Howrah.

The plant grows into a large bush, the branches of which have a tendency to elongate and overtop all other low vegetation and cover it up with its dense foliage. It appears to be a perennial; the light blue flowers, the petals of which are filament-like, are produced in enormous masses at the end of the rains and when ripe set free quantities of the light pappus seeds, which get widely distributed through the agency of the wind.

I have not noticed this plant anywhere in the United Provinces nor in the Central Provinces or South India, and the possibilities of its spread in damp areas, like the West Coast of India, where climatic conditions are very much as in Assam and Burma, are indeed very great, and I am of opinion that precautions ought to be taken to prevent its spread into regions which it has not yet reached.

Lippia geminata, originally a native of North and South America, is another introduced garden plant, which has shown definite tendencies of spreading. It is a small shrub with smooth and velvety silver grey leaves characterized by a fine *Citrus* scent and light purplish flowers borne on elongate spikes. It is plentiful on the banks of the River Gandak at Pusa and I have noticed it growing in abundance all along the sides of the B. & N.-W. Railway line between Chapra and Sonepur, and between Barauni and Katihar, forming dense masses in lowlying areas by the side of the rivers. In Bengal and in Assam and in parts of Orissa it was noticed in similar situations. Rai Bahadur U. Kanjilal informed me that he had found this plant, which according to him is known to the Assamese as "*Pichas lakdi*" (or devil stick), spreading in lowlying areas near rivers in the Brahmaputra Valley. This plant was also noted by me on the plateau of the Khasi Hills. In South India, the only place I have noticed it is on the banks of a canal at Chettipalayam Cane Breeding Station where it was introduced from North India by Dr. C. A. Barber.

Several Australian Wattles have been introduced into the Nilgiris, especially *Acacia dealbata*. Though they are undoubtedly of economic importance, the wood and the bark especially being useful, they have shown definite

tendencies of aggressiveness. Not only are the seeds produced abundantly but the plant is capable of spreading by a system of suckers, so that, when once an area has been planted with it, it appears to be extremely difficult to get rid of. When planted with other forest trees, it is reported to have the effect of choking up the rest.

Jatropha gossypifolia (Tropical Asia and Africa) is another plant which under peculiar conditions has been noted increasing in abundance and covering up the ground.

In addition to the above, there are several garden plants which have shown similar tendencies. Around some of the Hill Stations it is not an uncommon sight to find *Zinnia* and *Cosmos*, both American plants, straying in numbers into pastures and open waste-lands. At Gudalur in the Nilgiri Wynaad, a balsam, *Impatiens balsamina* ?, has escaped into waste areas and was found growing in masses, even on the tops of the tiled buildings in that moist tract. A perennial sunflower which I found cultivated in a great many places in India and Burma also exhibits tendencies of running wild.

There are two European plants, *Ulex europæus* and *Cytisus scoparius*, which have been introduced in the Nilgiris through the agency of the Nilgiri Hunt, that have shown aggressive tendencies.

Lastly there are certain indigenous plants which have, possibly due to the displacement of the balance of Nature by man, been found to spread exceedingly so as to form a serious factor sometimes in forestry, such as species of *Strobilanthes* in Burma and the Western Ghats, *Urtica dioica* (*Bichchu*) in the Himalayas, and *Pogostemon plectranthoides* in the Nilgiris and Central Provinces.

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